CAPITAL PROJECTS CONSTRUCTION STANDARDS

DENVER WATER

Volume 1 of 3
4th Edition

General Conditions
Standard Technical Specifications
Divisions 1-22

Capital Projects Construction Standards
Volume 1 of 3
4th Edition

July 2021

Denver Water
1600 West 12th Avenue
Denver, Colorado 80204
www.denverwater.org

Capital Projects Construction Standards
Volume 1 of 3 – 4th Edition

CONTENTS

DIVISION 3 – CONCRETE (CONTINUED)

DIVISION 4 – MASONRY

DIVISION 5 – METALS

DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

DIVISION 7 – THERMAL AND MOISTURE PROTECTION (CONTINUED)

DIVISION 8 – OPENINGS

DIVISION 9 – FINISHES

DIVISION 10 – SPECIALTIES

Capital Projects Construction Standards
July 2021

The Capital Projects Construction Standards, 4th Edition (CPCS) establishes the standard requirements for projects within the Denver Water service area including Denver Water Capital Projects. The CPCS includes General Conditions, Standard Technical Specifications, and Standard Details that are no longer referenced in the individual project Contract Documents. (The General Conditions apply exclusively to Denver Water Capital Projects.) Project-specific changes and additions to the CPCS in the form of the Supplementary Technical Specifications, bidding and other contract requirements, and Project Specific Details, will be prepared separately for each Capital Project. Used in conjunction with the Engineering Standards, projects approved under the Denver Water Plan Review process shall adhere to the Technical Specifications and Standard Details.

Denver Water is not responsible for the use of any portion of this document by any public agency or private entity. No representation or warranty of any kind is made concerning the accuracy, completeness, suitability, or utility of any information or product referenced in this document, and Denver Water assumes no liability arising from such use.

Denver Water may issue periodic revisions or may revise and reprint the entire document at its discretion. The CPCS is available online: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-construction-standards

INTENTIONALLY BLANK

Acknowledgements

Denver Water wishes to acknowledge and thank the individuals and organizations that contributed to the development of this 4th Edition:

CPCS Project Team

Robert J. Mahoney, P.E.	*Chief Engineering Officer*
Jeremy M. Ross, P.E.	*Director of Engineering – Projects*
Katie Ross, P.E.	*Engineering Manager, Distribution*
Warren Geissler	*Drafting Manager*
Amy Guire	*Division Analyst*
Sharon Solomon	*Technical Writer*

Subject Matter Experts

Jeff Archer, P.E.	*Engineering Manager, Mechanical*
Darren Brinker, P.E.	*Engineering Manager, Dam Safety*
Antonio Flori, P.E.	*Engineer, Corrosion Protection*
Bill Haywood, AIA	*Lintjer + Haywood Architects, P.C.*
Mark Keilwitz, P.E.	*Electrical Engineering Manager*
Tim LaPan, R.L.A.	*Senior Landscape Architect*
Cindy Marshall, P.E.	*Hydraulics Engineering Manager*
Kirk Petrik, P.E.	*Director of Engineering – Construction Management*
Kristi Riegle	*Attorney Senior*
Josh Smith, P.E.	*Engineering Manager, Materials Lab*
Matt Turney, P.E.	*Engineering Manager, Infrastructure*
Ryan Walsh, P.E.	*Engineering Manager, Water Treatment*

Additional Contributors

Jay Adams
Mike Aragon
Jessica Barbier, P.E.
Denis Baires
Lisa Berkness
Amy Beth
Rick Bistram
Jeremy Borchardt
David Buckley
Lee Burke
Bryan Campbell
Daniela Castaneda, P.E.
Casey Dick, P.E.
Anne Doud
Lars Ellingson, P.E.
David Fairburn, P.E.
Sean Hansz, P.E.
Brian Ivery
Jared Heath, P.E.
Ariana Hyre, P.E.
Dustin Jabin, P.E.
Alix Joseph
Jessica Kirk
Jeff Martin, P.E.
Brad McClintock
Pete McCormick, P.E.
Mike Mercier
Wyatt Millard
Nisha Nelson, P.E.
Michael Ortega
Sam Pegues
Paul Ries, P.E.
Damian Romero
Thomas Rupprecht, P.E.
Brian Salomonsson, P.E.
Fred Sanchez
Joshua Schwartz
Devin Shable, P.E.
Kevin Sparrow, P.E.
Mark Thomas
Gediminas Vaicikauskas
Kelly Wasserbach, P.E.
Richard Weber, P.E.

INTENTIONALLY BLANK

GENERAL CONDITIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

INTENTIONALLY BLANK

GENERAL CONDITIONS

INDEX

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

T

U

V

W

INTENTIONALLY BLANK

GENERAL CONDITIONS

ARTICLE 1--DEFINITIONS

Wherever used in these General Conditions or in other Contract Documents, the following terms shall have the meanings indicated herein, which are applicable to both singular and plural forms thereof.

Addenda--Written or graphic instruments issued prior to the opening of Bids that clarify, correct, or change the Bidding Documents or the Contract Documents.

Agreement--The written document between the OWNER and the CONTRACTOR that covers the Work to be performed; other Contract Documents shall be attached and made a part thereof. Defined herein as "Contract."

Allowances--Items of Work that cannot be definitively quantified prior to the actual performance of the Work. Allowances are provided for items of Work that are anticipated to occur.

Amendment--A document modifying the Construction Documents to add Work not originally included in the Contract Documents.

Application for Payment--The document used by the CONTRACTOR to request progress or final payments, includes supporting documentation required by the Contract Documents.

Asbestos--Any material that contains more than 1% Asbestos and is friable or is releasing fibers into the air above current action levels established by the Occupational Safety and Health Administration (OSHA).

As-Builts--As-Built Drawings are Final For Construction Drawings modified to show the as-constructed or as-built condition of the Work. These Drawings reflect the changes made in the Specifications and Final For Construction Drawings during the construction process, and are based on redlined drawings provided by the CONTRACTOR and the Construction Project Inspector. The completed As-Built Drawings are also known as Record Drawings.

Bid--The Bidder's offer or proposal, submitted on the prescribed form, setting forth the prices for the Work to be performed.

Bid Package--Applicable to CMAR and CM/GC Contracts. A biddable component of a Work Package.

Bidder--Any person, firm, or corporation submitting a Bid for the Work.

Bidding Documents--The advertisement or Invitation to Bid, Instructions to Bidders, the Bid form, and the proposed Contract Documents (including Addenda issued prior to the receipt of Bids).

Bidding Requirements--The advertisement or Invitation to Bid, Instructions to Bidders, and the Bid form.

Board--Synonymous with OWNER.

Bonds--Bid, performance and payment bonds, and other instruments of security.

Capital Projects Construction Standards (CPCS)--Includes General Conditions, Standard Technical Specifications, and Standard Details that are binding and referenced by the Contract Documents, but not copied and included within the individual project Contract Documents.

Change Order--An Agreement between the OWNER and the CONTRACTOR that authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Time or Contract Price that is issued on or after the Effective Date of the Agreement.

Chief Engineering Officer--The person designated by Denver Water to lead its Division of Engineering and Construction.

Claim--A written demand for payment of money, extension of time, or other relief allowed by this Contract.

CM/GC--Construction Manager/General Contractor alternative delivery method.

CMAR--Construction Manager At Risk alternative delivery method.

Conformed Documents--Synonymous with Final for Construction Documents.

Construction Project Manager--The authorized representative of the ENGINEER assigned to the site, or any part thereof, to observe the Work and to perform certain other obligations of the ENGINEER.

Contingency--Funds added to the total Contract Price to cover added costs for completing the Work. Contingency included in a WP for CMAR or CM/GG projects may be CONTRACTOR- or OWNER-controlled.

Contract--Synonymous with Agreement.

Contract Documents--The Agreement, the Addenda, the CONTRACTOR's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications, and the Drawings identified as "Contract Documents" in the Agreement, together with Amendments, modifications, and supplements incorporated into a Change Order on or after the Effective Date of the Agreement and any other documents that are designated "Contract Documents" by the OWNER. No one part of the Contract Documents shall constitute the Contract or Agreement; the whole, taken together, shall be the Agreement between the parties.

Contract Price--The amount payable by the OWNER to the CONTRACTOR for the completion of the Work in accordance with the Contract Documents as stated in the Agreement.

Contract Time--The number of days (computed as indicated in Paragraph 17.2.) or the dates stated in the Agreement for the completion of the Work.

CONTRACTOR--The person, firm, or corporation with whom the OWNER has entered into the Agreement to perform the Work.

Cost Loaded Schedule (CLS)--A detailed schedule of individual activities required to complete the Work and associated cost that the CONTRACTOR anticipates requesting partial payment for as the activity is progressively completed. References to schedule or construction schedule shall mean CLS. The activities and associated costs in the CLS shall be equal to the Contract Price.

Day--Calendar day.

Defective--An adjective used to refer to Work that is unsatisfactory, faulty, or deficient; fails to conform to the Contract Documents; fails to meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents or has been damaged prior to the final payment (unless responsibility for the protection thereof has been assumed by the OWNER in accordance with this Agreement).

Denver Water--The property and personnel under the control of the City and County of Denver, acting by and through its Board of Water Commissioners.

Direct Work--Applicable to CM/GC Contracts. Also known as Direct Cost, the actual construction Work performed on the Project. This includes subcontracts, material purchases, and equipment purchases; Self Perform Work includes labor, materials, equipment, and construction equipment.

Drawings--The Drawings that show the scope, extent, and character of the Work to be furnished and performed by the CONTRACTOR which have been prepared or approved by the ENGINEER and are referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

Effective Date of the Agreement--The date indicated in the Contract on which it becomes effective. If no such date is indicated, the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

ENGINEER--The Chief Engineering Officer or the Chief's authorized representative.

Engineering Standards--Standards promulgated by the CEO/Manager of Denver Water and administered by the Chief Engineering Officer, as amended from time to time, that provide uniform requirements for the installation, operation, and maintenance of water facilities and the materials and equipment used for such facilities.

Fee--Applicable to CMAR and CM/GC Contracts. An amount specifically identified in the Guaranteed Maximum Price that the parties have agreed the OWNER will pay to the CONTRACTOR for performing the Work in addition to the cost of the Work itself.

Field Order--A written directive issued by the ENGINEER for the implementation of minor changes to the Work (in accordance with Paragraph 9.5.). This directive does not involve a change in the Contract Price or the Contract Time.

Final Completion--All Work has been completed in the opinion of the ENGINEER as evidenced by the ENGINEER's definitive letter certifying "Final Completion" in accordance with the Contract Documents. Award of Final Completion by the ENGINEER to the CONTRACTOR first requires the CONTRACTOR to provide the ENGINEER with final versions of applicable project paperwork including Submittals, operation and maintenance manuals, as-builts, and the completion of operational testing and associated paperwork.

Final for Construction--The Agreement, exhibits to the Agreement, these General Conditions, Supplementary Conditions, Specifications, and Drawings that have been modified to include any addendum items; the final version of issued for construction; synonymous with Conformed Documents.

Guaranteed Maximum Price (GMP)--The total sum that is mutually accepted by the OWNER and the CONTRACTOR for a Work Package Proposal. The CONTRACTOR shall be responsible for costs in excess of the mutually accepted sum.

Hazardous Chemicals--Chemicals that contain substances that can burn, explode, have toxic release hazards, or may cause other damage to persons or property. Hazardous chemicals may include, but are not limited to, aqua ammonia, chlorine (liquid and gas), oxygen (liquid), hydrofluosilicic acid (liquid fluoride), sodium fluorosilicate (fluoride), potassium permanganate, 50% caustic soda solution, and aluminum sulfate in aqueous solution with sulfuric acid (alum).

Hazardous Substances--Hazardous Materials and Hazardous Wastes, as defined by the Occupational Health and Safety Administration (OSHA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that include, but are not limited to, Asbestos, PCBs, Petroleum, Hazardous Waste, and Radioactive Material.

Hazardous Waste--The term shall have the meaning provided in § 1004 of the Solid Waste Disposal Act (42 U.S.C. § 6903).

Indirect Work--Applicable to CM/GC Contracts. Work that is necessary to complete the Project beyond the cost of Direct Work and is limited to allowable general conditions costs, project Fees, CONTRACTOR's Bonds, CONTRACTOR's insurance, and permit costs; also known as Indirect Cost.

Laws or Regulations--Any applicable laws, rules, regulations, ordinances, codes, and orders of any governmental bodies, agencies, authorities, and courts having jurisdiction.

Lump Sum--A payment procedure under which the OWNER agrees to pay the CONTRACTOR a specified amount for completing the Work including a cost breakdown at the time of invoicing.

Manufacturer--A person, group, company, or fabricator who has a contract with the CONTRACTOR or Subcontractor to produce goods or products to be incorporated into the Work.

Mark-Up--The portion of the total contract amount that is not directly attributable to the cost of the Work including, but not limited to, overhead and profit.

Milestone--A principal event specified in the Contract Documents that relates to an intermediate completion date or a time prior to the Substantial Completion of the Work.

Notice of Award--The written notice by the OWNER to the apparent successful Bidder stating that upon compliance by the apparent Successful Bidder with the terms and conditions precedent enumerated therein, within the time specified, as part of the Contract Agreement. Once accepted, the OWNER will sign and deliver the Agreement.

Notice to Proceed--A written notice provided by the OWNER to the CONTRACTOR that fixes the date on which the Contract Time will begin and on which the CONTRACTOR shall initiate performance of its obligations under the Contract Documents.

OWNER--The Board of Water Commissioners of the City and County of Denver, which is formally designated as the City and County of Denver, a municipal corporation of the State of Colorado, acting by and through its Board of Water Commissioners that is at times referred to as "Board" or "Denver Water."

OWNER's Consultant--The person, firm, or corporation retained by the OWNER to provide engineering services as the OWNER's independent professional associate.

Partial Utilization--Use by the OWNER of a substantially completed part of the Work for the purpose for which it is intended, or a related purpose, prior to Substantial Completion for the Work.

PCBs--Polychlorinated biphenyls.

Petroleum--Petroleum, including crude oil, or any fraction thereof that is liquid at standard conditions of temperature and pressure [60° Fahrenheit (15.6° Celsius) and 14.7 pounds per square inch absolute (100 kilo Pascals)]. Examples: Fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

Plans--Synonymous with Drawings when used in Contract Documents.

Potential Fire, Explosion, or Toxic Release Hazards--The chemicals aqua ammonia and chlorine (or liquid chlorine).

Project--The total construction of the Work to be provided under the Contract Documents or a part of the Work as indicated elsewhere in the Contract Documents.

Radioactive Material--Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. § 2011 et seq.) and as regulated by the Colorado Department of Public Health and Environment (CDPHE).

Record Documents--The documents, certifications, Drawings, and other information related to the Work, materials, and equipment the CONTRACTOR and the ENGINEER required and used to complete the Work that reflect the final condition of the Work.

Request for Information (RFI)--A standard process primarily used to gather information to make a decision, confirm the interpretation of a detail, Specification, or note on the construction drawings, or to secure a documented directive or clarification needed to continue work.

Samples--Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and establish standards by which such portion of the Work will be judged.

Shop Drawings--All drawings, diagrams, illustrations, schedules, and other data or information specifically prepared or assembled by or for the CONTRACTOR and are submitted by the CONTRACTOR to illustrate some portion of the Work.

Specifications--Those portions of the Contract Documents that consist of written technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the Work and certain administrative details applicable thereunto. Standard Specifications that are not included in a project's Contract Documents are provided in the Capital Projects Construction Standards (CPCS).

Subcontractor--An individual, firm, or corporation that has a contract with the CONTRACTOR or with any other Subcontractor for the performance of a portion of the Work at the site.

Submittals--Shop Drawings, Samples, drafts, information, manuals, warranties, documents, and the like furnished to the ENGINEER by the CONTRACTOR, or by the Supplier through the CONTRACTOR, as required by the Contract Documents.

Substantial Completion--The Work (or a specified part thereof) has progressed to the point where it is sufficiently complete in the opinion of the ENGINEER as evidenced by the ENGINEER's definitive letter certifying "substantial completion." It is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if there be no such letter issued, when final payment is due in accordance with Paragraph 14.14. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof.

Supplementary Conditions--The part of the Contract Documents that amends or supplements these General Conditions. The Supplementary Conditions are a component of the Supplementary Technical Provisions.

Supplementary Technical Provisions--The part of the Contract that amends or supplements the General Conditions, Technical Specifications, and/or Standard Details contained in the Capital Projects Construction Standards (CPCS).

Supplier--A distributor, material man, or vendor who has a contract with the CONTRACTOR or Subcontractor to furnish materials or equipment to be incorporated into the Work.

Surety--A corporate entity authorized to do business in the State of Colorado, which executes as Surety thereon any Bond filed with the OWNER pursuant to these Contract Documents by the Bidder or the CONTRACTOR.

Total Project Cost--Applicable to CMAR and CM/GC Contracts. The estimate of cost agreed to by the OWNER and the CONTRACTOR and the maximum total cost the OWNER will pay to the CONTRACTOR for the project. Change Orders modify the Total Project Cost. Costs incurred by the CONTRACTOR in excess of the Total Project Cost, which includes any approved Change Orders, will be at the cost and risk of the CONTRACTOR.

Undefined Holds--Applicable to CMAR Contracts. An amount specifically identified in the GMP that the parties have agreed the OWNER will pay to the CONTRACTOR for performing Work that is not within the scope of the Subcontractors' Work.

Underground Facilities--Pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities that have been installed underground to furnish any of the following services or materials: Electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

Unit Price Work--Work to be paid for based on component prices.

Work--The entire completed construction, or the various separately identifiable parts thereof, that are required to be furnished under the Contract Documents. Work includes and is the result of performing services, furnishing labor, furnishing and incorporating materials and equipment into the construction, performing or furnishing services, and furnishing documents as required by the Contract Documents.

Work Change Directive--A written order to the CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by the Construction Project Manager, that requires an addition, deletion, or revision in the Work, is in response to differing or unforeseen physical conditions under which the Work is to be performed as provided in the Agreement, or is in response to emergencies under the Agreement. A Work Change Directive may not change the Contract Price nor the Contract Times, but it is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Time as provided in the Agreement.

Work Package--Applicable to CMAR and CM/GC Contracts. The set of documents, including Drawings and Specifications, that describes a phase of the total Work upon which a GMP is based; comprised of one or more Bid Packages.

ARTICLE 2--PRELIMINARY MATTERS

Delivery of Bonds:

2.1. When the CONTRACTOR delivers the executed Agreements to the ENGINEER, the CONTRACTOR shall also deliver to the ENGINEER such Bonds and Certificates of Insurance as the CONTRACTOR may be required to furnish in accordance with ARTICLE 5.

Copies of Documents:

2.2. The ENGINEER will furnish to the CONTRACTOR pdfs of the Conformed Contract Documents, one copy of the Specification, one full sized set of the Final for Construction Drawings and two reduced sized sets of the Final for Construction Drawings (unless otherwise specified in the Supplementary Conditions) for the execution of the Work. Additional copies shall be the responsibility of the CONTRACTOR. The OWNER may elect to furnish electronic access of Contract Documents to the CONTRACTOR.

Commencement of Contract Time; Notice to Proceed:

2.3. The Contract Time will commence on the Date indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 45 days after the Effective Date of the Agreement.

Starting the Project:

2.4. The CONTRACTOR shall begin the Work on the date when the Contract Time commences. No Work shall be permitted at the site prior to the start date. The CONTRACTOR shall perform the Work in accordance with Contract Documents that are “Conformed” and Drawings that are marked “Final for Construction” only.

Before Starting Construction:

2.5. Before undertaking each part of the Work, the CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon in addition to applicable field measurements. The CONTRACTOR shall report, in writing, to the Construction Project Manager any conflict, error, or discrepancy that the CONTRACTOR may discover within 7 days and shall obtain a written interpretation or clarification from the Construction Project Manager before proceeding with any Work affected thereby; however, the CONTRACTOR shall not be liable to the OWNER for the failure to report any conflict, error, or discrepancy in the Contract Documents, unless the CONTRACTOR had actual knowledge thereof or should reasonably have known thereof.

2.6. Within 30 days after the date of the Notice to Proceed, or as specified in the Contract Documents, the CONTRACTOR shall submit the following to the Construction Project Manager for review:

2.6.1. A CLS as detailed in the Specifications. The final CLS, submitted and reviewed in accordance with Paragraph 2.9., shall provide an orderly progression of the Work to completion within the Contract Time. Such submittal of an approved CLS by the CONTRACTOR will be a prerequisite for any extension of Contract Time pursuant to ARTICLE 12. The ENGINEER’s review of the CLS will neither impose upon the ENGINEER the responsibility for the progress or scheduling of the Work nor relieve the CONTRACTOR from any responsibility thereof. Time that elapses while the CONTRACTOR obtains approval of a submitted CLS is not a basis for an extension of Contract Time or an increase in Contract

Price as long as the ENGINEER or the OWNER's Consultant has acted in accordance with Specification 01 33 00.

2.6.2. A 30-day preliminary progress schedule detailing those activities that will take place after the Pre-Construction Meeting and before submittal of the CLS. On-site Work may be prohibited until submission and approval of this schedule by the ENGINEER.

2.6.3 A preliminary cost sheet that indicates the predicted change order pricing including labor rates and burdens, equipment rates, mark-ups, overhead and profit, and insurance and bond costs, unless directed otherwise by the ENGINEER.

2.6.4 A safety plan may be required that includes a project-specific risk mitigation plan designed to mitigate those project-specific risks identified in the Contract Documents, in addition to typical construction safety information.

2.7. Before the Notice to Proceed is issued, the CONTRACTOR shall deliver to the ENGINEER certificates (and other evidence of insurance requested by the OWNER) that the CONTRACTOR is required to purchase and maintain in accordance with ARTICLE 5.

Pre-Construction Meeting:

2.8. Before the CONTRACTOR starts Work at the site, a meeting attended by the CONTRACTOR, the Construction Project Manager, the ENGINEER, and others considered appropriate by the parties will be held to discuss the items referred to in Paragraph 2.6.; to discuss administration and communication procedures including handling Shop Drawings, operations and maintenance manuals, and other Submittals; for processing Applications for Payment; and to establish a working understanding between the parties as to the Work.

Finalizing Schedules:

2.9. At least 10 days prior to the submission of the first Partial Payment Application, a meeting will be held, in accordance with Paragraph 2.8, to finalize the CLS submitted. The meeting shall be attended by the CONTRACTOR, the ENGINEER, and others, as appropriate.

Effect of CONTRACTOR's Failure to Submit Information:

2.10. The CONTRACTOR acknowledges that its submittal of the information required, as listed above, is necessary for subsequent determinations regarding the issuance of Change Orders and Work Directive Changes and that failure to submit this information creates a rebuttable presumption that no Change Order or Work Directive Change is due.

ARTICLE 3--CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

Intent:

3.1. The Contract Documents will comprise the entire Agreement between the OWNER and the CONTRACTOR concerning the Work. The Contract Documents are complementary, i.e., what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the laws of the State of Colorado. This Contract is and shall be deemed to be performable in the City and County of Denver, notwithstanding that the parties may find it necessary to take action in furtherance of or compliance with the Contract outside said City and County. Disputes between the OWNER and the CONTRACTOR will be resolved by an administrative hearing as set forth in ARTICLE 16.

The CONTRACTOR shall not utilize the Contract Documents for purposes unrelated to the performance of Work hereunder and shall not make the Contract Documents available to the general public, this includes availability through the CONTRACTOR's promotional materials or website. The CONTRACTOR shall immediately inform the OWNER if the CONTRACTOR becomes aware that any of its Subcontractors or employees has disclosed any of the Contract Documents.

The CONTRACTOR's use of the Contract Documents shall be strictly limited to the terms of any project-specific Disclosure Agreement.

3.2. The intent of the Contract Documents is to describe a functionally complete Project (or a part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result shall be furnished and performed whether or not specifically stated. When words or phrases that have

a well-known technical, construction industry, or trade meaning are used to describe Work, materials, or equipment, such words or phrases will be interpreted in accordance with that meaning. Clarifications and interpretations of the Contract Documents will be issued by the ENGINEER as provided in Paragraph 9.4. The Contract Documents may reference specific details in the CPCS or requirements in the Engineering Standards. Where references are not specifically identified, the CONTRACTOR shall refer to the CPCS and the Engineering Standards and incorporate these standard details, standard drawings and engineering standards into the Project, or the CONTRACTOR shall obtain ENGINEER approval of proposed alternatives that meet the minimum standard requirements for constructing capital projects similar to the references listed in the CPCS and the Engineering Standards.

3.3. **Reference to Standards and Specifications of Technical Societies: Reporting and Resolving Discrepancies:**

3.3.1. The reference to standards, Specifications, manuals, or codes of any technical society, organization, or association or to Laws or Regulations of any governmental authority, whether such reference be specific or implied, means the latest standard, Specification, manual, code, Law, or Regulation in effect at the time of Bid opening (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.3.2. If the CONTRACTOR discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work, of any such standard, Specification, manual, or code or of any instruction of any Supplier referred to in Paragraph 6.5., the CONTRACTOR shall report it to the Construction Project Manager, in writing, within 48 hours and the CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as authorized by Paragraph 6.22.) until an Amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.4. or 3.5.; provided, however, that the CONTRACTOR will not be liable to the OWNER for failure to report any such conflict, error, ambiguity, or discrepancy unless the CONTRACTOR knew or reasonably should have known thereof.

3.3.3. Except as otherwise specifically stated in the Contract Documents, or as may be provided by Amendment or supplement thereto, issued by one of the methods indicated in Paragraph 3.4. or 3.5., the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:

3.3.3.1. Reference to standards, Specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, Specification, manual, code, Law, or Regulation in effect at the time of opening the Bids (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.3.3.2. The provisions of any such Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in the violation of such Laws or Regulations).

No provision of any such standard, Specification, manual, code, or instruction shall be effective to change the duties and responsibilities of the OWNER, the CONTRACTOR, the ENGINEER, or any of their Subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to the OWNER, the ENGINEER, or any of the OWNER's Consultants, agents, or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility that is inconsistent with the provisions of Paragraph 9.13. or any other provision of the Contract Documents.

In the case of a conflict or a discrepancy, the following hierarchal list dictates the order of precedence:

a. Change Orders, Amendments, and Work Change Directives
b. RFIs and Field Orders
c. Project-Specific Specifications
d. P&IDs, Contract Drawings, or other Record Drawings
e. Contract Drawings – Dimensions on Drawings shall govern over scale Drawings

f. Submittals, Shop Drawings

g. Verbal Direction

In the event an item of Work is described differently in two or more locations on the Drawings, request clarification from the Construction Project Manager.

Amending and Supplementing Contract Documents:

3.4. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work, or to modify the terms and conditions thereof, in one or more of the following ways:

3.4.1. A formal Amendment,

3.4.2. A Change Order (pursuant to Paragraph 10.4.), or

3.4.3. A Work Change Directive (pursuant to Paragraph 10.1.).

3.5. In addition, the requirements of the Contract Documents may be supplemented and minor variations and deviations in the Work may be authorized in one or more of the following ways:

3.5.1. A Field Order issued (pursuant to Paragraph 9.5 or 10.1.),

3.5.2. The ENGINEER's approval of a Submittal (pursuant to Paragraphs 6.25. and 6.26.), or

3.5.3. The ENGINEER's written interpretation or clarification (pursuant to Paragraph 9.4).

Reuse of Documents:

3.6. The CONTRACTOR, Subcontractor, Supplier, or other person or organization performing or furnishing any of the Work under a direct or indirect contract with the OWNER shall not have nor shall they acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies thereof) prepared by or bearing the seal of the ENGINEER. They shall not reuse Drawings, Specifications, or other documents on extensions of the Project or on any other project without the written consent of the ENGINEER and the OWNER's Consultant(s) (where applicable), which consent may be conditioned upon specific written verification or adaptation by the ENGINEER and the OWNER's Consultant(s) (where applicable).

Electronic Data Release:

3.7. Any electronic drawing data provided to the CONTRACTOR by Denver Water may be used for this Contract only. The delivery of electronic drawing data under this Contract constitutes a non-exclusive, limited license for the CONTRACTOR to use the information in Denver Water's electronic files for the specific purpose of fulfilling the requirements of the Contract. Nothing in Denver Water's transfer of electronic drawing data related to this Contract shall be construed to create any right of CONTRACTOR, its subcontractors, or suppliers to reuse the information provided in any form or for any other purpose, to transfer the data to any other party except to Subcontractors and Suppliers as necessary for the Work. Electronic drawing files shall not be considered Contract Documents. The CONTRACTOR agrees to assume all risks associated with exchanges of electronic drawing data, including but not limited to data erosion, erasure or alteration of electronic files, and viruses that may cause disruption or damage to CONTRACTOR's computer resources.

The CONTRACTOR further agrees to the fullest extent permitted by law to hold harmless and indemnify Denver Water, its officers, employees, agents and consultants from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising out of or in any way connected with the use, modification, misinterpretation, misuse or reuse by others of the electronic drawing data provided under this Contract. The foregoing indemnification applies, without limitation, to any use by CONTRACTOR or its subcontractors or suppliers of the electronic drawing data provided for by this Contract.

ARTICLE 4--AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; CONTROL POINTS

Availability of Lands:

4.1. The OWNER will furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access thereunto, and such other lands designated for the use of the CONTRACTOR. The OWNER will identify any encumbrances or restrictions not of general application but specifically related to the use of lands so furnished with which the CONTRACTOR shall have to comply in performing the Work.

Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the OWNER, unless otherwise provided in the Contract Documents. The CONTRACTOR shall be responsible for acquiring any additional lands for construction outside the limits of that provided by the OWNER. The CONTRACTOR shall also provide for additional lands and access thereunto that may be required for temporary construction facilities or the storage of materials and equipment.

4.2. **Subsurface and Physical Conditions:**

4.2.1. The CONTRACTOR shall refer to the following information regarding subsurface and physical conditions:

4.2.1.1. For Subsurface Conditions, the CONTRACTOR shall refer to those reports of explorations and tests of subsurface conditions at or contiguous to the site that have been utilized by the ENGINEER in preparing the Contract Documents; and

4.2.1.2. For Physical Conditions, the CONTRACTOR shall refer to those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) that have been utilized by the ENGINEER in preparing the Contract Documents.

4.2.2. Limited Reliance by the CONTRACTOR on Technical Data. The CONTRACTOR shall rely upon the general accuracy of the "technical data" contained in the reports and drawings (referenced above), but such reports and drawings are not themselves Contract Documents unless specifically identified as such. "Technical data" is identified in appropriate sections of the Contract Documents. Except for such reliance on "technical data," the CONTRACTOR shall not rely upon nor make any Claim against the OWNER, the ENGINEER, or any of the OWNER’s Consultants with respect to:

4.2.2.1. The completeness of such reports and drawings for the CONTRACTOR's purposes including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by the CONTRACTOR and safety precautions and programs incident thereunto, or

4.2.2.2. Other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings, or

4.2.2.3. Any CONTRACTOR interpretation of or conclusion drawn from any "technical data" or any such data, interpretations, opinions, or information.

4.2.3. Notice of Differing Subsurface or Physical Conditions. If the CONTRACTOR believes that any subsurface or physical condition of the site that is uncovered or revealed is:

4.2.3.1. Of such a nature as to establish that any "technical data" on which the CONTRACTOR is entitled to rely upon as provided in Paragraphs 4.2.1. and 4.2.2. is materially inaccurate; or

4.2.3.2. Materially different from that shown or indicated in the Contract Documents; or

4.2.3.3. Of an unusual nature and materially different from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then the CONTRACTOR shall, promptly (but no later than 5 days) after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as permitted by Paragraph 6.22.), notify the Construction Project Manager, in writing, about the condition. The written notification referenced above shall be titled “Notice of Potential Differing Condition” and include a description of the basis for the CONTRACTOR’s belief that a differing condition exists; the effect of the condition on the Work; and any other facts available that are relevant to the situation.

The CONTRACTOR shall not further disturb the conditions or perform any Work in connection therewith (except as aforesaid) until receipt of a written order to do so. (The ENGINEER may issue such order prior to issuing the ENGINEER’s findings and conclusions described below).

4.2.4. The ENGINEER's Review. Upon receipt of the CONTRACTOR’s written notice (referenced above), the ENGINEER will promptly schedule a meeting with the CONTRACTOR to discuss the items described in the CONTRACTOR’s notice. The ENGINEER will also review the pertinent conditions, determine the

necessity of obtaining additional exploration or tests and the necessity for the CONTRACTOR to obtain third-party analysis, and advise the CONTRACTOR, in writing, of the ENGINEER's findings and conclusions.

4.2.5. Possible Contract Documents Change. If the ENGINEER concludes that a change in the Contract Documents is required as a result of a condition that meets one or more of the categories in Paragraph 4.2.3., a Work Change Directive, a Field Order, or a Change Order will be issued as provided in ARTICLE 10 to reflect and document the consequences of such change.

4.2.6. Possible Price and Times Adjustments. If the ENGINEER concludes that an equitable adjustment in the Contract Price, the Contract Time, or both, is required as a result of a condition that meets one or more of the categories in Paragraph 4.2.3. and causes an increase or decrease in the CONTRACTOR's cost of, or time required for performance of, the Work, a Work Change Directive, a Field Order, or a Change Order will be issued as provided in this Agreement, subject to the following:

4.2.6.1. Such condition shall meet any one or more of the categories described in Paragraphs 4.2.3.1. through 4.2.3.3., inclusive;

4.2.6.2. A change in the Contract Documents pursuant to Paragraph 4.2.5. will not be an automatic authorization of nor a condition precedent to entitlement to any such adjustment;

4.2.6.3. With respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.10. and 11.9.; and

4.2.6.4. The CONTRACTOR shall not be entitled to any adjustment in the Contract Price nor the Contract Time if:

4.2.6.4.1. The CONTRACTOR knew of the existence of such conditions at the time the CONTRACTOR made a final commitment to the OWNER in respect to Contract Price and Contract Time by the submission of a Bid or by becoming bound under a negotiated Contract; or

4.2.6.4.2. The existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for the CONTRACTOR prior to the CONTRACTOR's making such final commitment; or

4.2.6.4.3. The CONTRACTOR failed to give written notice within the timeframe required by Paragraph 4.2.3. or a schedule required elsewhere in the Contract Documents.

4.2.6.5. If the ENGINEER and the CONTRACTOR are unable to agree on entitlement to or the extent of an equitable adjustment in the Contract Price or Contract Time related to the occurrence of the above conditions, a Claim may be initiated as provided in ARTICLE 16. However, the OWNER, the ENGINEER, and the OWNER’s Consultants shall not be liable to the CONTRACTOR for any costs, losses, or damages sustained by the CONTRACTOR on, or in connection with, any other project or anticipated project due to any alleged delay associated with the Work.

4.3. Physical Conditions specifically consisting of Underground Facilities: In addition to Paragraph 4.2., the following shall apply to Physical Conditions of the site that consist specifically of Underground Facilities:

4.3.1. Shown or Indicated: The information and data shown or indicated in the Contract Documents, with respect to existing Underground Facilities at or contiguous to the site, is based on information and data furnished to the ENGINEER by the OWNER, by the owners of such Underground Facilities, or others.

4.3.1.1. The OWNER will not be responsible for the accuracy or completeness of any such information or data; and,

4.3.1.2. The CONTRACTOR shall have full responsibility for reviewing and checking such information and data, for locating Underground Facilities shown or indicated in the Contract Documents, for the coordination of Work with the owners of such Underground Facilities during construction, for the safety and protection thereof as provided in Paragraph 6.19., and for

repairing any damage resulting from the Work, the cost of which will be considered as having been included in the Contract Price. The CONTRACTOR shall perform this review, checking and locating shown or indicated Underground Facilities prior to construction, with sufficient lead time to allow the OWNER or the owners of Underground Facilities to correct or mitigate interferences with the Work.

4.3.2. Not Shown or Not Indicated: If an Underground Facility exists at or is contiguous to the site that was not shown or indicated in the Contract Documents and that the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall promptly, no later than 48 hours, after becoming aware thereof and before performing any Work affected thereby (except in an emergency as permitted by Paragraph 6.22.), identify the owner of the Underground Facility giving written notice thereof to that owner and to the Construction Project Manager. The ENGINEER will promptly review the Underground Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground Facility and the Contract Documents may be amended or supplemented as necessary. During such time, the CONTRACTOR shall be responsible for the safety and protection of such Underground Facility as provided in Paragraph 6.19.

The CONTRACTOR shall expect normal utility service lines to commercial and residential properties. These include water, sewer, telephone, cable television, gas, and electric. Such lines will not normally be shown in the Contract Documents. The CONTRACTOR shall not be entitled to any adjustment of Contract Price or Contract Time associated with locating, avoiding, relocating, or repairing such services. The fact that some or any of the service lines are shown on the Drawings is not a representation that service lines are shown or indicated.

Control Points:

4.4. The ENGINEER will provide engineering surveys to establish primary control points for construction, which in the ENGINEER's judgment are necessary to enable the CONTRACTOR to proceed with the Work. The CONTRACTOR shall be responsible for laying out the Work (unless otherwise specified in the Contract Documents), shall protect and preserve the established control points, and shall make no changes or relocations without the prior written approval of the ENGINEER. The CONTRACTOR shall report to the ENGINEER whenever any control point is lost or destroyed or requires relocation because of necessary changes in grades or locations. The CONTRACTOR shall be responsible for the cost of the accurate replacement or relocation of such control points by professionally qualified personnel selected or approved by the ENGINEER.

4.5. **Hazardous Substances:**

4.5.1. The OWNER will be responsible for any Hazardous Substances (e.g., Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material) uncovered or revealed at the site that were not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and that may present a substantial danger to persons or property exposed thereunto in connection with the Work at the site. The OWNER will not be responsible for any such materials brought to the site by the CONTRACTOR, Subcontractor, Suppliers, or anyone else for whom the CONTRACTOR is responsible.

4.5.2. Upon discovery of a Hazardous Substance, the CONTRACTOR shall immediately (i) stop Work in connection with such Hazardous Substance and in any area affected thereby (except in an emergency as required by Paragraph 6.22.) and (ii) notify the ENGINEER (and thereafter confirm such notice in writing). The ENGINEER will promptly determine the necessity for the OWNER to retain a qualified expert to evaluate such Hazardous Substance or take corrective action, if any. The CONTRACTOR will not be required to resume Work in connection with such Hazardous Substance or in any such affected area until after the OWNER has obtained any required permits related thereunto and delivered to the CONTRACTOR special written notice (i) specifying that any affected area is or has been rendered safe for the resumption of Work or (ii) specifying any special conditions under which such Work may be resumed safely. If the ENGINEER and the CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Time as a result of such Work stoppage or such special conditions under which Work will be resumed, the ENGINEER will make the determination and the CONTRACTOR may dispute said determination through a Claim as provided in ARTICLE 16.

4.5.3. If the CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe or does not agree to resume such Work under special conditions after the receipt of such special written notice, then the OWNER may order such portion of the Work that is in connection with such Hazardous

Substance or in such affected area to be deleted from the Work. If the ENGINEER and the CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Time as a result of deleting such portion of the Work, then the ENGINEER will make the determination and the CONTRACTOR may dispute the determination through a Claim as provided in ARTICLE 16. The OWNER may have such deleted portion of the Work performed by the OWNER's personnel, or others, in accordance with ARTICLE 7.

4.5.4. To the fullest extent permitted by Laws or Regulations, the OWNER will indemnify and hold harmless the CONTRACTOR, Subcontractors, Consultants, and the officers, directors, employees, agents, other Consultants, and Subcontractors of each of them from and against Claims, costs, losses, and damages arising out of or resulting from such Hazardous Substance, provided that (i) any such Claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom and (ii) nothing in this Subparagraph 4.5.4. shall obligate the OWNER to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.

4.5.5. The provisions of Paragraphs 4.2. and 4.3. shall not apply to Hazardous Substances uncovered or revealed at the site.

Water Treatment Chemicals:

4.6. For Work at Treatment Plants, operating chemical systems on the property where the Work is located may include, but are not limited to, Aqua Ammonia, Chlorine (liquid and gas), Hydrofluosilicic Acid (liquid Fluoride), Potassium Permanganate, 50% Caustic Soda Solution, Aluminum Sulfate in aqueous solution with sulfuric acid (Alum), Sodium Fluorosilicate (Fluoride), and Ferric Chloride. Copies of the Safety Data Sheets (SDS) are available at the Work site. Compliance with the required Environmental Health and Safety Program and Employee Safety Training as specified in the Contract Documents is required.

Work performed in the vicinity of the aqua ammonia and chlorine systems shall be performed only in the presence of and with the assistance of the OWNER's plant operator. Control of CONTRACTOR's entrance, presence, and exit shall be the responsibility of the OWNER.

ARTICLE 5--BONDS AND INSURANCE

Performance and Other Bonds:

5.1. The CONTRACTOR shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of the CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date when final payment becomes due, except as otherwise provided by Laws or Regulations or by any and all requirements imposed by the Contract Documents. Bonds shall be in the forms prescribed by Laws or Regulations or by the Contract Documents, executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department, and rated "A-" or better by A. M. Best Company. Bonds signed by an agent shall be accompanied by a certified copy of the authority to act. The Bid package shall include proof of A. M. Best ratings. The CONTRACTOR shall use the latest versions of forms EJCDC C-610 and EJCDC C-615 for this Project.

Under unique or unusual circumstances, if the CONTRACTOR wishes to use another company as the provider of any Bond required hereunder, the CONTRACTOR shall obtain written approval from the OWNER prior to Bid.

5.2. If the Surety on any Bond furnished by the CONTRACTOR is declared bankrupt, becomes insolvent, its right to do business is terminated in any state where any part of the Project is located, or it ceases to meet the requirements of Paragraph 5.1., the CONTRACTOR shall, within 5 days thereafter, substitute another Bond and Surety, both of which must be acceptable to the OWNER.

CONTRACTOR's Insurance:

5.3. Throughout the time the CONTRACTOR is performing Work pursuant to this Agreement, the CONTRACTOR shall maintain, and ensure that its Subcontractors maintain, insurance that meets the requirements set forth:

5.3.1. Workers' compensation insurance as required under the workers' compensation laws of the State of Colorado.

5.3.2. Commercial general liability insurance with limits of not less than $1,000,000 per occurrence and $2,000,000 aggregate. Such insurance shall include "The City and County of Denver, Acting By and Through its Board of Water Commissioners" and, if requested by the Board, any Consultant retained by the Board to perform Work on this Project, as additional insured and shall be primary and non-contributing with respect to any insurance or self-insurance program of the Board. The CONTRACTOR shall maintain this insurance for 2 years after final payment and for the duration of the applicable Colorado statute of repose.

5.3.3. Business automobile insurance with limits of not less than $1,000,000 per occurrence. Such insurance shall include coverage for owned, non-owned, and hired vehicles utilized in the performance of this Agreement.

5.3.4. Professional liability insurance with a limit of not less than $2,000,000 per Claim is required for licensed professional services such as, but not limited to, architectural, engineering, or survey services in the performance of this Agreement.

5.3.5. "All Risks" builder's risk insurance at least as broad in scope as the Insurance Services Office ("ISO") "Cause of Loss – Special form." Such insurance shall:

5.3.5.1. Cover the full projected value of the completed Project;

5.3.5.2. Not include coinsurance requirements;

5.3.5.3. Include soft cost coverage for additional accounting costs, legal costs, and any other increase in expense incurred due to an insured event;

5.3.5.4. Include equipment breakdown coverage or its equivalent;

5.3.5.5. Continue in force until final completion and the OWNER's acceptance;

5.3.5.6. Include "The City and County of Denver, Acting By and Through its Board of Water Commissioners" as insured as its interests may appear, and, if requested by the Board, any Consultant retained by the Board to perform Work on this Project.

5.3.6. OTHER REQUIREMENTS AND PROVISIONS

5.3.6.1. The CONTRACTOR's insurers shall maintain an A.M. Best rating of A-, Class VII or better.

5.3.6.2. Self-insured retentions or deductibles shall be declared and approved by the Board and shall be paid solely by the CONTRACTOR without reimbursement by the OWNER.

5.3.6.3. 30 day advance notice of cancellation shall be provided to the Board.

5.3.6.4. The OWNER may modify these requirements at its discretion.

Evidence of Insurance:

5.4. The CONTRACTOR shall provide to the Board certificates of insurance (and renewals thereof) demonstrating that the insurance requirements have been met. Certificates of insurance shall contain a clause in this form: The above described policies shall not be canceled, modified, or amended or coverage reduced without the issuing company providing 30 days advance written notice to the certificate holder.

5.5. The CONTRACTOR shall provide copies of insurance policies upon the request of the Board.

Colorado Governmental Immunity Act:

5.6. Any language contained herein notwithstanding, the OWNER continues to rely upon, and has not waived, the monetary limits and all other rights, immunities, and protections provided by the Colorado Governmental Immunity Act, Colorado Revised Statutes, § 24-10-101, et seq. The OWNER's exposure to liability, whether directly by reason of its own negligence, or indirectly through indemnification, contract, subrogation or otherwise, is as stated in the Act.

ARTICLE 6--CONTRACTOR'S RESPONSIBILITIES

Supervision and Superintendence:

6.1. The CONTRACTOR shall supervise and direct the Work competently and efficiently, devoting such attention thereunto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction but the CONTRACTOR shall not be responsible for the negligence of others in the design or selection of a specific means, method, technique, sequence, or procedure of construction that is indicated in and required by the Contract Documents. The CONTRACTOR shall be responsible to see that finished Work complies with the Contract Documents. The CONTRACTOR shall comply with its Non-Disclosure Agreement with the OWNER, and it shall maintain appropriate confidentiality of Contract Documents, **which obligation shall flow down to its Subcontractors and Suppliers**.

6.2. The CONTRACTOR shall designate, in writing, a competent project manager and full-time superintendent who is on-site at all times during construction and who shall not be replaced without written notice to the Construction Project Manager. The project manager shall be present on-site during construction and be in attendance at weekly progress meetings, project site visits, other coordination meetings, and as required. The superintendent shall be the CONTRACTOR's representative at the site and shall have authority to act on behalf of the CONTRACTOR. Communications given to the superintendent shall be as binding as if given to CONTRACTOR. The CONTRACTOR shall immediately remove from the Work any person employed, including the CONTRACTOR's superintendent, on the site whom the ENGINEER determines to be uncooperative or disorderly. At a minimum, the OWNER and the ENGINEER may require the CONTRACTOR, the Subcontractors, and the Suppliers to provide the names of employees entering the OWNER's sites and may require those employees to provide identification to access such sites.

Labor, Materials, and Equipment:

6.3. The CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the Work using the horizontal and vertical control provided by the OWNER and to perform construction as required by the Contract Documents. The CONTRACTOR shall, at all times, maintain good discipline and order at the site except in connection with the safety or protection of persons, or the Work, or property at the site or adjacent thereunto, and except as otherwise indicated in the Contract Documents.

For conduits, the ENGINEER shall provide engineering surveys to establish an alignment of offset control points parallel to the proposed pipeline alignment. The offset distance shall be determined by a joint effort between the CONTRACTOR and the ENGINEER relative to the trench width. The CONTRACTOR shall keep the ENGINEER informed, a reasonable time in advance, of the time and places at which it intends to work in order that offset control points can be set by the ENGINEER in advance of the Work. All costs involved in delays resulting from short notice given by the CONTRACTOR shall be borne by the CONTRACTOR. The CONTRACTOR shall preserve line and grade stakes and markers set by the ENGINEER unless the CONTRACTOR is authorized to do otherwise. Any points destroyed by the CONTRACTOR through its negligence, shall be replaced by the ENGINEER. The OWNER reserves the right to charge the CONTRACTOR for any replacements due to negligence.

Work at the site shall be performed during regular working hours and shall not start earlier or end later than allowed by local jurisdictional codes. Working hours are the responsibility of the CONTRACTOR; the OWNER will have no additional liability for overtime or shift time unless approved beforehand.

OWNER-recognized Holidays consist of the following days:

New Year's Day (January 1st)

Martin Luther King Day (3rd Monday in January)

President's Day (3rd Monday in February)

Memorial Day (Last Monday in May)

Independence Day (July 4th, or observed weekday)

Labor Day (1st Monday in September)

Veteran's Day (November 11th or observed weekday)

Thanksgiving Day (4th Thursday in November)

Christmas Day (December 25th, or observed weekday)

6.4. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish and assume full responsibility for materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and other facilities, and incidentals necessary for the furnishing and installing, performance, testing, startup, and completion of the Work.

6.5. Materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by the ENGINEER, the CONTRACTOR shall furnish all of its documentation (including bills of lading, reports of required tests, Supplier invoices, etc.) as to the quantity, kind, and quality of materials and equipment utilized in the Work. Materials and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents.

Construction Schedule:

6.6. The CONTRACTOR shall adhere to the construction schedule as it may be adjusted from time to time as provided herein:

6.6.1. The CONTRACTOR shall submit proposed adjustments in the construction schedule that will not change the Contract Time (or Milestones) to the Construction Project Manager. Such adjustments shall conform generally to the construction schedule then in effect and shall comply with any provisions of the General Conditions applicable thereunto.

6.6.2. Proposed adjustments in the construction schedule that will change the Contract Time (or Milestones) shall be submitted in accordance with the requirements of Paragraph 12.1. Such adjustments may only be made by a Change Order or an Amendment in accordance with ARTICLE 12.

6.7. **Substitute or Or-Equal Items:**

6.7.1. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the naming of the item is intended to establish the type, function, and quality required. Unless the technical Specifications indicate that no substitution is permitted, materials or equipment of other Suppliers may be accepted by the ENGINEER if the CONTRACTOR submits sufficient information to allow the ENGINEER to determine that the material or equipment proposed is equal to that named. The procedure for review by the ENGINEER will follow the guidelines listed herein and as they may be supplemented in the Supplementary Conditions. Requests for a review of substitute items of material and equipment will not be accepted by the ENGINEER from anyone other than the CONTRACTOR. If the CONTRACTOR wishes to furnish or use a substitute item of material or equipment, the CONTRACTOR shall make written application to the ENGINEER for acceptance thereof, certifying that the proposed substitute will adequately perform the functions and achieve the results called for by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified. The application shall state that evaluation and acceptance of the proposed substitute will not prejudice the CONTRACTOR's on time achievement of Substantial Completion whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other contract with the OWNER for Work on the Project) to adapt the design to the proposed substitute, and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any licensing or royalty. Variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair, and replacement service shall be indicated. The application shall also contain an itemized estimate of costs that will result directly or indirectly from the acceptance of such substitute including costs of redesign and Claims of other contractors affected by the resulting change, all of which will be considered by the ENGINEER in evaluating the proposed substitute. The ENGINEER may require the CONTRACTOR to furnish, at the CONTRACTOR's expense, additional data about the proposed substitute.

6.7.2. If a specific means, method, technique, sequence, or procedure of construction is indicated in or required by the Contract Documents, the CONTRACTOR shall furnish or utilize a substitute means, method, sequence, technique, or procedure of construction acceptable to the ENGINEER if the CONTRACTOR submits sufficient information to allow the ENGINEER to determine that the substitute proposed is equivalent to that indicated or required by the Contract Documents. The procedure for review by the

ENGINEER will be similar to that provided in Paragraph 6.7.1. as applied by the ENGINEER and as may be supplemented in the Supplementary Conditions.

6.7.3. The ENGINEER will evaluate each proposed substitute within a reasonable timeframe. The ENGINEER will be the sole judge of acceptability and no substitute will be ordered, installed, or utilized without the ENGINEER's prior written acceptance, which will be evidenced by either a Change Order or an approved Shop Drawing. The OWNER, acting through the ENGINEER, may require the CONTRACTOR to furnish, at the CONTRACTOR's expense, a special performance guarantee or other Surety with respect to any substitute. The ENGINEER will record the time required by the ENGINEER and the OWNER's Consultant in evaluating substitutions proposed by the CONTRACTOR and in making changes in the Contract Documents occasioned thereby. Whether or not the ENGINEER accepts a proposed substitute, the OWNER may require the CONTRACTOR to reimburse the OWNER for the charges of the ENGINEER and the OWNER's Consultant for the evaluation of each proposed substitute.

6.8. **Concerning Subcontractors, Suppliers, and Others:**

6.8.1. The CONTRACTOR shall not employ any Subcontractor, Supplier, or other person or organization against whom the OWNER or the ENGINEER have reasonable objection. The CONTRACTOR shall not be required to employ any Subcontractor, Supplier, or other person or organization to furnish or perform any of the Work against whom the CONTRACTOR has reasonable objection.

6.8.2. The CONTRACTOR shall provide to the ENGINEER, within 10 days of the Effective Date of Agreement or Work Package (CMAR and CM/GC Contracts), a complete listing including addresses and telephone numbers of Subcontractors and Suppliers proposed for use (including those who are to furnish the principal items of materials and equipment) for acceptance by the ENGINEER. The OWNER's or the ENGINEER's acceptance (either in writing or by failing to make written objection thereunto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other person or organization so identified may be revoked on the basis of reasonable objection after due investigation in which case the CONTRACTOR shall submit an acceptable substitute. The Contract Price may be adjusted, in accordance with ARTICLE 10, for the difference in the cost associated by such substitution. No acceptance by the OWNER or the ENGINEER of any such Subcontractor, Supplier, or other person or organization will constitute a waiver of any right of the OWNER or the ENGINEER to reject Defective Work.

6.8.3. The CONTRACTOR shall be fully responsible to the OWNER for acts and omissions of the Subcontractors whether selected by the CONTRACTOR or by the OWNER, Suppliers, and other persons and organizations performing or furnishing any of the Work for the CONTRACTOR just as the CONTRACTOR is responsible for the CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create any contractual relationship between the OWNER and any such Subcontractor, Supplier, or other person or organization, nor shall it create any obligation on the part of the OWNER to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other person or organization except as may otherwise be required by Laws or Regulations.

6.8.4. The CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other persons and organizations performing or furnishing any of the Work for the CONTRACTOR. The CONTRACTOR shall require Subcontractors, Suppliers, and any such persons or organizations performing or furnishing any of the Work to communicate with the ENGINEER through the CONTRACTOR.

6.9. The divisions and sections of the Specifications and the identifications of any Drawings shall not control the CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.10. Work performed for the CONTRACTOR by a Subcontractor shall be pursuant to an appropriate agreement between the CONTRACTOR and the Subcontractor that specifically binds the Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of the OWNER. The CONTRACTOR shall pay each Subcontractor a just share of any insurance moneys received by the CONTRACTOR on account of losses under policies issued pursuant to Paragraph 5.3., as their interests may appear.

Patents and Royalties:

6.11. The CONTRACTOR shall pay licensing and royalties and assume costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device that is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of the OWNER or the ENGINEER, its use is subject to patent rights or copyrights calling for the payment of any licensing or royalty to others, the existence of such rights will be disclosed by the ENGINEER or the OWNER's Consultant in the Contract Documents. The CONTRACTOR shall indemnify and hold harmless the OWNER and anyone directly or indirectly employed by the OWNER from and against Claims, damages, losses, and expenses (including attorneys' costs and court proceedings and alternative dispute resolution costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents and shall defend such Claims in connection with any alleged infringement of such rights.

Permits and Licenses:

6.12. Unless otherwise provided, the CONTRACTOR shall obtain and pay for permits and licenses required in the execution of the Work with no Mark-Up. The OWNER will obtain any permits and licenses the OWNER deems necessary to expedite the Work, and any permits and licenses so obtained will be identified in the appropriate sections of the Contract Documents. An appropriate adjustment to Contract Price shall be made for any permits and licenses obtained by the OWNER that the Contract Documents required the CONTRACTOR to obtain. The CONTRACTOR shall pay applicable charges and inspection costs necessary for the execution of the Work that are required at the time of the opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. The CONTRACTOR shall acquire any occupancy permit if such is required for the OWNER to utilize the Work. The CONTRACTOR shall pay charges of utility owners for connections to the Work, and the OWNER will pay charges of such utility owners for capital costs related thereunto such as plant investment. The CONTRACTOR shall comply with the requirements of permits and licenses obtained by the OWNER and/or the CONTRACTOR.

6.13. **Laws and Regulations:**

6.13.1. The CONTRACTOR shall give notices and comply with Laws or Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws or Regulations, neither the OWNER, the ENGINEER, nor the OWNER's Consultant will be responsible for monitoring the CONTRACTOR's compliance with any Laws or Regulations. The CONTRACTOR shall certify that it has complied, and during the term of this Agreement shall continue to comply with all applicable laws including the Immigration Reform and Control Act of 1986.

6.13.2. If the CONTRACTOR observes that Specifications or Drawings are at variance with any Laws or Regulations, the CONTRACTOR shall give the Construction Project Manager immediate written notification, within 24 hours of such observation, and any necessary changes will be made by one of the methods indicated in Paragraph 3.5. If the CONTRACTOR performs any Work knowing or having reason to know that it is contrary to such Laws or Regulations, and without such notice, the CONTRACTOR shall bear costs arising therefrom.

Sales and Use Taxes (Excise Taxes):

6.14. The CONTRACTOR shall pay sales, consumer, use, and other similar taxes required to be paid by the CONTRACTOR in accordance with the Laws or Regulations of the place of the Project that are applicable during the performance of the Work.

The Total Project Cost shall include such taxes in accordance with the following:

6.14.1. Colorado State Taxes. The State of Colorado will not impose sales and use taxes upon construction and building materials purchased by the CONTRACTOR and Subcontractors for use in the building, erection, alteration, or repair of structures, highways, roads, streets, and other public works owned and used by the OWNER. To qualify for this exemption, an application for a certificate of exemption shall be filed by the CONTRACTOR with the Department of Revenue, State of Colorado, by the CONTRACTOR and the Subcontractors engaged in the Project. Bids shall not include any such taxes in the computation.

6.14.2. Local Taxes. The CONTRACTOR and each Subcontractor are required to pay the sales and use taxes imposed by any political subdivision of the State of Colorado on purchases of any tangible personal property to be built into the Work. Each proposal shall include such taxes with no adjustment for any refund that the OWNER may subsequently receive.

6.14.3. Federal Taxes. As a political subdivision of the State of Colorado, the OWNER is exempt from the payment of most federal excise taxes. The Contract Price shall not include federal excise tax of any kind in the computation. An exemption certificate will be provided by the OWNER for those items to which the exemption applies. The CONTRACTOR will be reimbursed for payment of any federal excise tax for which the OWNER is unable to provide an exemption certificate.

Use of Premises:

6.15. The CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the site, land, and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws or Regulations, rights-of-way, permits, and easements and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. The CONTRACTOR shall assume full responsibility for any damage to any such land or area, to the OWNER or occupant thereof, or of any adjacent land or areas, resulting from the performance of the Work. Should any Claim be made by any such owner or occupant because of the performance of the Work, the CONTRACTOR shall promptly settle with such other party by negotiation or otherwise resolve the Claim by other dispute resolution proceeding or at law. The CONTRACTOR shall, to the fullest extent permitted by Laws or Regulations, indemnify and hold harmless the OWNER, the ENGINEER, the OWNER's Consultant, and anyone directly or indirectly employed by them from and against Claims, costs, losses, and damages arising out of or resulting from any Claim or action, legal or equitable, brought by any such owner or occupant against the OWNER, the ENGINEER, or any other party indemnified hereunder to the extent caused by or based upon the CONTRACTOR's or a Subcontractor's performance of the Work.

6.16. During the progress of the Work, the CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish, and other debris resulting from the Work. At the completion of the Work, the CONTRACTOR shall remove waste materials, rubbish, and debris from and about the premises as well as tools, appliances, construction equipment, machinery, and surplus materials. The CONTRACTOR shall leave the site clean and ready for occupancy by the OWNER at Substantial Completion of the Work. The CONTRACTOR shall restore to original condition property not designated for alteration by the Contract Documents.

6.17. The CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall the CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it. The CONTRACTOR shall be responsible for monitoring costs that are required for adjacent structures.

Record Documents:

6.18. The CONTRACTOR shall maintain, in a safe place at the site, one record copy of Drawings, Specifications, Capital Projects Construction Standards, Engineering Standards, Addenda, Amendments, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications (issued pursuant to Paragraph 9.4.) in good order and annotated to show changes made during construction. These record documents together with approved Samples and Shop Drawings shall be available to the ENGINEER for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings shall be delivered to the Construction Project Manager.

Safety and Protection:

6.19. The CONTRACTOR shall be responsible for initiating, maintaining, and supervising safety precautions and programs in connection with the Work. The CONTRACTOR shall take necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

6.19.1. Employees on the Work and other persons and organizations who may be affected thereby;

6.19.2. Work, materials, and equipment to be incorporated therein, either in storage on-site or off-site; and

6.19.3. Other property at the site or adjacent thereunto including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

6.19.4. The CONTRACTOR, when Work involves chemicals identified in Paragraph 4.5 and/or 4.6, shall have, implement, and submit their Environmental Health and Safety Program and shall implement an Employee Safety Training Program including, but not limited to, safety procedures for working on or around fire, explosion, or toxic release hazards and complying with all requirements provided in ARTICLES 2, 4, and 17 of the General Conditions.

The CONTRACTOR shall comply with applicable Laws or Regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury, or loss and shall erect and maintain necessary safeguards for such safety and protection. The CONTRACTOR shall notify the owners of adjacent property and of Underground Facilities and utility owners when execution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. Damage, injury, or loss to any property, referred to in Paragraph 6.19.2. or 6.19.3., that is caused, either directly or indirectly, in whole or in part, by the CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by them to perform or furnish Work or anyone for whose acts they may be liable, shall be remedied by the CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of the OWNER or the ENGINEER, the OWNER's Consultant, or anyone employed by them or anyone for whose acts they may be liable). The CONTRACTOR's duties and responsibilities for the safety and protection of the Work shall continue until such time as the Work is completed and the ENGINEER has issued a notice to the CONTRACTOR in accordance with Paragraph 14.13. that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.20. The CONTRACTOR shall designate a full-time, responsible representative at the site when Work is occurring whose duty shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs. This person shall be the CONTRACTOR's superintendent unless otherwise designated, in writing, by the CONTRACTOR to the Construction Project Manager.

Hazard Communication Programs:

6.21. The CONTRACTOR shall be responsible for coordinating any exchange of safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the site in accordance with Laws or Regulations. The CONTRACTOR shall be responsible for ensuring all employees, Subcontractors, Subcontractor employees, and any other persons on-site to perform Work are informed of the information provided in Paragraph 4.5, and receive the required training as set forth in these Contract Documents. The CONTRACTOR shall comply with all requirements pertaining to Hazardous Chemicals; Potential Fire, Explosion, or Toxic Release Hazards; and enforce controlled entrance, presence, and exit to chlorine and/or ammonia systems in accordance with the General Conditions and DIVISION 1 Specifications contained in these Contract Documents.

Emergencies:

6.22. In emergencies affecting the safety or protection of persons, the Work, or property at the site or adjacent thereunto, the CONTRACTOR, without special instruction or authorization from the ENGINEER, is obligated to act to prevent threatened damage, injury, or loss. The CONTRACTOR shall give the ENGINEER prompt written notice if the CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused. If the ENGINEER determines that a change in the Contract Documents is required due to the action taken in response to an emergency, a Work Change Directive, a Field Order, or a Change Order will be issued to document the consequences of the changes or variations.

Submittal Procedures:

6.23. After checking and verifying field measurements and after complying with applicable procedures specified herein, the CONTRACTOR shall make Submittals in accordance with the CLS as referenced in the Specifications. Submittals shall bear a stamp or specific written indication that the CONTRACTOR has satisfied its responsibilities under the Contract Documents with respect to the review of the submission including those developed by others including Suppliers and Subcontractors. Submissions shall be identified as required in the Specifications. The data shown on the Submittals shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to enable the ENGINEER to review and approve the information as required with no more than two submissions of the same Submittal. ENGINEER time, costs, and delays for reviewing subsequent resubmittals, Samples, or other items shall be compensated in accordance with the Specifications.

6.24. The CONTRACTOR shall submit to the Construction Project Manager, for the ENGINEER to review with such promptness as to cause no delay in Work, Samples required by the Contract Documents. If the CONTRACTOR fails to perform the necessary review required herein, submissions will be promptly returned by the ENGINEER without review. Samples shall have been checked and accompanied by a specific written indication that the CONTRACTOR has satisfied its responsibilities under the Contract Documents with respect to the review of the submission and shall be identified clearly as to material, Supplier, pertinent data such as catalog numbers, and the intended use.

6.24.1. Before submission of each Shop Drawing or Sample, the CONTRACTOR shall have determined and verified quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereunto and reviewed or coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

6.24.2. At the time of each submission, the CONTRACTOR shall give the ENGINEER specific written notice of each variation that the Shop Drawings or Samples may have from the requirements of the Contract Documents and shall cause a specific notation of each such variation to be made on each Shop Drawing submitted for review and approval.

6.24.3. The CONTRACTOR shall provide to the ENGINEER its CDPHE stormwater management plan and permit application in order to obtain the OWNER's signature as required by State regulations. Cost or schedule impacts due to permit delays resulting from insufficiency of the CONTRACTOR's approach, as determined by the State or the ENGINEER, shall be borne by the CONTRACTOR.

6.25. The ENGINEER or the OWNER's Consultant will review, with reasonable promptness, Submittals; the ENGINEER's review will be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences, or procedures of construction (except where a specific means, method, technique, sequence, or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereunto. The review of a separate item as such will not indicate approval of the assembly in which the item functions. The CONTRACTOR shall make corrections required by the ENGINEER and return the corrected Submittals for review and approval. The CONTRACTOR shall direct specific attention, in writing, to revisions other than the corrections called for by the ENGINEER on previous Submittals.

6.26. The ENGINEER's or the OWNER's Consultant's review and approval of Submittals does not relieve the CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless the CONTRACTOR has, in writing, called the ENGINEER's attention to each such variation at the time of submission, as required by Paragraph 6.24.2, and the ENGINEER has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Submittal approval; nor will any approval by the ENGINEER relieve the CONTRACTOR from responsibility for errors or omissions in the Submittals or from responsibility for complying with the provisions of Paragraph 6.24.1.

6.27. Where a Submittal is required by the Specifications, any related Work performed prior to the ENGINEER's or the OWNER's Consultant's review and approval of the pertinent submission will be at the sole risk and responsibility of the CONTRACTOR.

Information requests shall be submitted to the ENGINEER using the RFI form. Follow the procedures specified in ARTICLE 6 – SUBMITTAL PROCEDURES and supplement the form with any other appropriate information, submitted with attachments necessary for proper review by the ENGINEER. RFI Submittals found to contain errors or unapproved deviations or variations from the Contract may be determined by the ENGINEER to be out of compliance with the Contract. Any costs or delays associated with non-conforming RFIs are the CONTRACTOR's sole responsibility and the ENGINEER has no requirement to extend Contract Time or to make additional payments.

If the CONTRACTOR considers any comment by the ENGINEER on the returned RFI to constitute a change, it shall make such written notice in accordance with ARTICLE 10.

Continuing the Work:

6.28. The CONTRACTOR shall carry on the Work and adhere to the construction schedule during disputes or disagreements with the OWNER. No Work shall be delayed or postponed pending the resolution of any disputes or disagreements, except as permitted by Paragraph 15.4. or as the CONTRACTOR and the ENGINEER may otherwise specifically agree to, in writing.

CONTRACTOR's General Warranty and Guarantee:

6.29. The CONTRACTOR warrants and guarantees to the OWNER, the ENGINEER, and the OWNER's Consultants that Work will be in accordance with the Contract Documents and said Work will not be Defective. The CONTRACTOR's obligation to perform and complete Work in accordance with the Contract Documents shall be absolute.

The CONTRACTOR's warranty and guarantee hereunder excludes liability for defects caused by abuse, operation by persons other than the CONTRACTOR, Subcontractors, and Suppliers or by normal wear and tear under normal usage.

None of the following occurrences shall constitute an acceptance of Work that is not in strict compliance with the Contract Documents:

6.29.1. Observations by the ENGINEER;

6.29.2. Recommendation of any progress payment or final payment;

6.29.3. Issuance of a letter certifying Substantial Completion;

6.29.4. Any payment to the CONTRACTOR under the Contract;

6.29.5. Use or occupancy of the Work or any part thereof by the OWNER;

6.29.6. Any acceptance by the OWNER or failure to do so;

6.29.7. Any observation, test, or approval by others as well as review and/or approval of Submittals, as-builts, or issuance of notice of acceptability by the ENGINEER; or

6.29.8. Any notice or demand by the OWNER or the ENGINEER to correct Defective Work.

Indemnification:

6.30. To the fullest extent permitted by Laws or Regulations, the CONTRACTOR shall indemnify, defend, and hold harmless the OWNER and the OWNER's Consultant(s), their officers, directors, agents, and employees from and against Claims, damages, losses, and expenses, direct, indirect, or consequential (including, but not limited to, charges of engineers, architects, attorneys, and other professionals and court proceedings or other alternative dispute resolution costs) arising out of or resulting from the performance of the Work. The previous sentence shall apply only if such Claim, damage, loss, or expense (a) is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself) including the loss of use resulting therefrom and (b) is caused in whole or in part by any negligent act or omission of the CONTRACTOR, any Subcontractor, any person or organization directly or indirectly employed by them to perform or furnish any of the Work, or anyone for whose acts they may be liable. This paragraph applies regardless of causation by or negligence of a party indemnified hereunder, and regardless of whether the Claim, damage, or loss arises from or is imposed by Laws or Regulations.

6.31. In any and all Claims against the OWNER and the OWNER's Consultant(s), their officers, directors, agents, and employees by any employee of the CONTRACTOR, any Subcontractor, any person or organization directly or indirectly employed by them to perform or furnish any of the Work, or anyone for whose acts they may be liable, the indemnification obligation under Paragraph 6.30. shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any such Subcontractor, other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

6.32. The indemnification obligations of the CONTRACTOR under Paragraph 6.30. shall not extend to the liability of the ENGINEER and the OWNER's Consultants, officers, directors, employees, or agents caused by the professional negligence, errors, or omissions of them.

Survival of Obligations:

6.33. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work, and termination or completion of the Agreement.

Damage To Work:

6.34. Except as provided in ARTICLE 14 of the General Conditions and in the Supplementary Conditions, the CONTRACTOR shall be responsible for damage to the Work until the final payment is made by the OWNER or until Partial Utilization of a portion of the Work by the OWNER. If the OWNER uses portions of the Work in accordance with the provisions of the Contract Documents concerning Partial Utilization, the CONTRACTOR will be relieved from responsibility for damages only for those portions of the Work utilized by the OWNER.

6.35. Should the CONTRACTOR cause damage to the Work or property of any separate contractor at the site, or should any Claim arising out of the CONTRACTOR's performance of the Work at the site be made by any separate contractor against the CONTRACTOR, the OWNER, the OWNER's Consultant, or any other person, the CONTRACTOR shall promptly attempt to settle with such other contractor by Agreement or to otherwise resolve the dispute. The CONTRACTOR shall, to the fullest extent permitted by Laws or Regulations, indemnify, defend, and hold the OWNER and the OWNER's Consultant harmless from and against Claims, damages, losses, and expenses (including, but not limited to, charges of engineers, architects, attorneys, and other professionals and court proceedings or other alternative dispute resolution costs) arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any separate contractor against the OWNER or the OWNER's Consultant to the extent based on a Claim arising out of the CONTRACTOR's performance of the Work. Should a separate contractor cause damage to the Work or the property of the CONTRACTOR or should the performance of Work by any separate contractor at the site give rise to any other Claim, the CONTRACTOR shall not institute any action, legal or equitable, against the OWNER or the OWNER's Consultant or permit any action against them to be maintained and continued in its name or for its benefit in any court or before any arbiter that seeks to impose liability on or to recover damages from the OWNER or the OWNER's Consultant on account of any such damage or Claim. If the CONTRACTOR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor, and the OWNER and the CONTRACTOR are unable to agree as to the extent of any adjustment in Contract Time attributable thereto, the CONTRACTOR may make a Claim for an extension of time in accordance with ARTICLE 12. An extension of the Contract Time will be the CONTRACTOR's exclusive remedy with respect to the OWNER and the OWNER's Consultant for any delay, disruption, interference, or hindrance caused by a separate contractor. This Paragraph does not prevent recovery from the OWNER or the OWNER's Consultant for activities that are their respective responsibilities.

Required Notifications:

6.36. The CONTRACTOR shall provide the notices required by the applicable sections (ARTICLES 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16) of these General Conditions in order to obtain a change in Contract Time, a change in Contract Price, or an equitable adjustment to the Contract Price. Otherwise, the CONTRACTOR shall be deemed to have waived its rights thereunder.

Approval of Assigned Agreements:

6.37. The CONTRACTOR shall not enter into any agreement purporting to bind OWNER to its terms, or that may become binding on OWNER by virtue of an assignment or otherwise, unless such an agreement has been expressly approved in writing by the OWNERS authorized representative. CONTRACTOR shall indemnify, defend, and hold the Board harmless from and against any claims, counterclaims, actions, causes of action, demands, damages, costs, expenses, or liabilities of any kind or nature related to the CONTRACTOR'S failure to comply with the foregoing obligation.

ARTICLE 7--OTHER WORK

Related Work at Site:

7.1. The OWNER may perform other Work related to the Project at the site by the OWNER's personnel, let other direct contracts therefor that will contain General Conditions similar to these, or have other Work performed by utility owners. If the fact that such other Work is to be performed was not noted in the Contract Documents, then (i) written notice thereof will be given to the CONTRACTOR prior to starting any such other Work, and (ii) the CONTRACTOR may make a Claim, as provided in ARTICLES 11 and 12, if such performance will involve additional expense to the CONTRACTOR or requires additional time and the parties are unable to agree as to the amount or extent thereof.

7.2. The CONTRACTOR shall afford each utility owner and each other contractor who is a party to such a direct contract (or the OWNER, if the OWNER is performing the additional Work with the OWNER's personnel) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such Work, and the CONTRACTOR shall properly connect and coordinate the Work with theirs. The CONTRACTOR shall do cutting, fitting, and patching of the Work that may be required to make its parts come together

properly and integrate with such other Work. The CONTRACTOR shall not endanger the Work of others by cutting, excavating, or otherwise altering their Work; they shall only cut or alter their Work with both the written consent of the ENGINEER and the others whose Work will be affected. The duties and responsibilities of the CONTRACTOR under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of the CONTRACTOR in said direct contracts between the OWNER and such utility owners and other contractors.

7.3. If the proper execution or results of any part of the CONTRACTOR's Work depends upon Work performed by others under this Article, the CONTRACTOR shall inspect such Work and promptly report to the Construction Project Manager, in writing, any delays, defects, or deficiencies in such other Work that render it unavailable or unsuitable for the proper execution and results of the CONTRACTOR's Work. The CONTRACTOR's failure to report such will constitute an acceptance of the Work as fit and proper for integration with the CONTRACTOR's Work except for latent defects in such other Work.

Coordination:

7.4. The OWNER reserves the right to let other contracts in connection with the completion of this Project. Performance of other contracts may be simultaneous with this Contract and within the same general area. The CONTRACTOR agrees to properly connect and coordinate the Work with that to be performed under other contracts or with Work done by the OWNER. Any dispute whatsoever between separate contractors shall be resolved as set forth in ARTICLE 16.

7.4.1. If the CONTRACTOR delays the Work of the OWNER or other contractors by improperly coordinating the Work or by not affording them sufficient opportunity or facility to perform the Work as may be specified, the CONTRACTOR shall in that case pay costs and expenses incurred by such parties due to any such delays and the CONTRACTOR hereby authorizes the OWNER to deduct the amount of such costs and expenses from any payments due or to become due to the CONTRACTOR under this Contract. However, nothing contained in this Paragraph shall relieve said CONTRACTOR from any liability resulting to the OWNER on account of such delay(s).

7.4.2. The OWNER agrees to include this Article in other contracts under its control affecting the Work or other work performed in the same general area as the Work under this Contract.

ARTICLE 8--OWNER'S RESPONSIBILITIES

8.1. The OWNER will issue communications to the CONTRACTOR through the ENGINEER unless specified otherwise herein.

8.2. The OWNER will furnish the data required of the OWNER under the Contract Documents promptly and will make payments to the CONTRACTOR promptly after they are due as provided herein.

8.3. The OWNER will provide lands, easements, engineering surveys to establish reference points, copies of reports of explorations, and tests of subsurface conditions as provided herein.

8.4. The OWNER will be liable within the limits set forth in Paragraph 5.6.

8.5. The OWNER will execute Change Orders as indicated in Paragraph 10.4.

8.6. The OWNER will be responsible for certain inspections, tests, and approvals as set forth in Paragraph 13.4.

8.7. The OWNER will have the right to stop Work, suspend Work, and terminate the Work of the CONTRACTOR as set forth herein.

8.8. The OWNER will not supervise, direct, or have control or authority over, nor be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereunto, or for any failure of the CONTRACTOR to comply with Laws or Regulations applicable to the furnishing or performance of the Work. The OWNER will not be responsible for the CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

8.9. The OWNER will be responsible for undisclosed Hazardous Substances uncovered or revealed at the site set forth in Paragraph 4.5.

ARTICLE 9--ENGINEER'S RESPONSIBILITIES

OWNER's Representative:

9.1. The ENGINEER will be the OWNER's representative during the construction period. The duties and responsibilities of the ENGINEER as the OWNER's representative during construction are set forth in the Contract Documents.

Visits To Site:

9.2. The ENGINEER will generally have continuous on-site representation to observe the progress and quality of the executed Work and to determine if the Work is proceeding in accordance with the Contract Documents. The ENGINEER's efforts will be directed toward providing the OWNER with a greater degree of confidence that the completed Work will conform to the Contract Documents. On the basis of such observations, the ENGINEER will keep the OWNER informed of the progress of the Work and will endeavor to guard the OWNER against defects and deficiencies in the Work.

9.2.1. The OWNER's Consultant will not be required to make exhaustive or continuous on-site inspections, observations, or visits to check the quality or quantity of the Work.

Project Representation:

9.3. The ENGINEER will name a Construction Project Manager to observe the execution of the Work and to perform certain other obligations of the ENGINEER.

Clarifications and Interpretations:

9.4. The ENGINEER will issue, with reasonable promptness, such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as are reasonably necessary. If the CONTRACTOR believes that a written clarification or interpretation justifies an increase in the Contract Price or an extension of the Contract Time and the parties are unable to agree to the amount or extent thereof, the CONTRACTOR may make a Claim as provided in ARTICLES 11 or 12.

Authorized Variations in Work:

9.5. The ENGINEER may authorize minor variations in the Work, from the requirements of the Contract Documents, which do not involve an adjustment in the Contract Price or the Contract Time and are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and will be binding on the OWNER and the CONTRACTOR who shall promptly perform the Work involved. If the parties are unable to agree as to the amount of the extension of Contract Time or extent thereof, the CONTRACTOR may make a Claim as provided in ARTICLES 11 or 12.

Rejecting Defective Work:

9.6. The ENGINEER may disapprove or reject Work the ENGINEER believes to be Defective and will also have authority to require special inspection or testing of the Work as provided in ARTICLE 13, whether or not the Work is fabricated, installed, or completed. No inspection, failure to reject, or acceptance of all or a part of the Work, nor any payments for any portion of the Work, nor any extensions of time, nor any possession or occupancy by the OWNER shall operate as a waiver of any provision of the Contract Documents or as a waiver of the OWNER's absolute right to have the provisions fully performed. No waiver or breach of the requirements of the Contract Documents shall be held to be a waiver of any other requirement.

Shop Drawings, Change Orders, and Payments:

9.7. In connection with the ENGINEER's responsibilities with regard to Shop Drawings and Samples, see Paragraphs 6.23. through 6.27. inclusive.

9.8. In connection with the ENGINEER's responsibilities with regard to Change Orders, see ARTICLES 10, 11, and 12.

9.9. In connection with the ENGINEER's responsibilities with regard to Applications for Payment, etc., see ARTICLE 14.

Determinations for Unit Prices:

9.10. The ENGINEER will verify the actual quantities and classifications of Unit Price Work performed by the CONTRACTOR. The ENGINEER will review with the CONTRACTOR the ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). The ENGINEER's written decisions thereon will be final and binding upon the CONTRACTOR unless, within 10 days after the date of such decision, the CONTRACTOR delivers to the ENGINEER a written objection to such a decision.

Limitations on ENGINEER's Responsibilities:

9.11. Neither the ENGINEER's authority to act under this Article or elsewhere in the Contract Documents nor any decision made by the ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of the ENGINEER to the CONTRACTOR, any Subcontractor, any Supplier, any other person or organization performing any of the Work, or to any Surety for any of them.

9.12. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as approved" or terms of like effect are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory" or adjectives of like effect are used to describe a requirement, direction, review, or judgment of the ENGINEER as to the Work, it is intended that such requirement, direction, review, or judgment will be solely to evaluate the Work for compliance with the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to the ENGINEER any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.13. or 9.14.

9.13. The ENGINEER will not be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction or the safety precautions and programs incident thereunto, and the ENGINEER will not be responsible for the CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

9.14. The ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR or of any Subcontractor, any Supplier, or of any other person or organization performing or furnishing any of the Work.

ARTICLE 10--CHANGES IN THE WORK

10.1. Without invalidating the Agreement and without notice to any Surety, the OWNER may, acting through the ENGINEER, at any time or from time to time, order additions, deletions, or revisions in the Work which will be authorized by an Amendment, a Work Change Directive, a Field Order, or a Change Order. Upon receipt of any such document, the CONTRACTOR shall promptly proceed with the Work involved that will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

The CONTRACTOR may also submit a Change Order request that will be addressed to the ENGINEER and shall be made within 10 days of the event, delay, or omission that is the basis of the request. If the CONTRACTOR fails to meet the 10-day requirement, the OWNER may reject all or a portion of the Change Order request.

10.2. If requested by the ENGINEER through a Field Order or a Work Change Directive, the CONTRACTOR shall provide pricing to the ENGINEER for review through a Proposed Change Order. The CONTRACTOR, within 20 days after receiving the Field Order or the Work Change Directive, shall provide the ENGINEER with a complete and itemized proposal which includes the estimated increase or decrease in the Contract Price attributable to the planned changes including any deductions for Work or materials that are no longer required as a result of the proposed change. The CONTRACTOR shall be responsible for any delays in the Work and any additional costs to the OWNER caused by the CONTRACTOR’s failure to submit a complete price proposal within the specified 20 days.

10.2.1. It shall be the CONTRACTOR’s responsibility to verify that amounts already appropriated or otherwise made available for the Contract are sufficient to cover the entire cost of the Work. Any Work undertaken or performed in excess of the amount appropriated or otherwise made available is undertaken or performed in violation of the terms of the Contract, without the proper authorization, and at the CONTRACTOR’s own risk.

10.3. If the ENGINEER and the CONTRACTOR are unable to agree as to the extent, if any, of an increase or decrease in the Contract Price or an extension or shortening of the Contract Time that should be allowed as a result of a Work Change Directive, a Claim may be made as provided in ARTICLES 11 or 12. The OWNER will reimburse the CONTRACTOR for the CONTRACTOR's costs on a monthly basis as set forth herein until a Change Order is finalized; however, in no instance is such payment due before the CONTRACTOR has submitted an estimate of the cost for the additional compensable Work to be performed.

10.4. The CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Time with respect to any Work performed that is not required by the Contract Documents as amended, modified, and supplemented as provided in Paragraphs 3.4. and 3.5., except in the case of an emergency as provided in Paragraph 6.22. and except in the case of uncovering Work as provided in Paragraphs 13.7. and 13.8.

10.5. The OWNER and the CONTRACTOR will execute appropriate Change Orders (or Amendments) regarding:

10.5.1. Changes in the Work that are ordered by the OWNER pursuant to Paragraph 10.1. and are required because of acceptance of Defective Work under Paragraph 13.12. or correcting Defective Work under Paragraph 13.13. or are agreed to by the parties;

10.5.2. Changes in the Contract Price or Contract Time that are agreed to by the parties; and

10.5.3. Changes in the Contract Price or Contract Time that embody the substance of any written decision pursuant to Paragraph 9.11.

10.5.4 If the CONTRACTOR disagrees with the Construction Project Manager's decision or considers that the decision requires extra Work, the CONTRACTOR shall, within 20 days, notify the Construction Project Manager in writing of the disagreement or of the claimed extra Work. Failure of the CONTRACTOR to notify the Construction Project Manager within the said 20 days shall constitute a waiver of the CONTRACTOR's right to thereafter assert a Claim resulting from such determination or decision.

10.6. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Time) is required by the provisions of any Bond to be given to a Surety, the giving of any such notice shall be the CONTRACTOR's responsibility and the amount of each applicable Bond will be adjusted accordingly. If specifically requested by the OWNER, a copy of each such notice to the Surety and evidence of adjustment of the bond amount shall be provided to the Construction Project Manager. Further, the OWNER may require such documentation prior to the OWNER's payment to the CONTRACTOR of the amount of the bond premium.

ARTICLE 11--CHANGE OF CONTRACT PRICE

11.1. The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to the CONTRACTOR for performing the Work. Duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR shall be at its expense without a change in the Contract Price.

11.2. The Contract Price may only be changed by a Change Order or by an Amendment. Any CONTRACTOR request for a Change Order shall be addressed as such to the ENGINEER and shall be made within 10 days of the event, delay, omission, decision, or denial that is the basis of the request if no other time period is specified herein. No such CONTRACTOR request will itself be considered a Claim. Based on the ENGINEER's decision or in the absence of a resolution to the CONTRACTOR's request for a Change Order, the CONTRACTOR may subsequently present a Claim as set forth in ARTICLE 16. Any Claim for an increase or decrease in the Contract Price shall be based on written notice delivered by the party making the Claim to the other party as set forth in ARTICLE 16.

11.3. The value of any Work covered by a Change Order or of any Claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:

11.3.1. By application of unit prices to the quantities of the items involved where the Work involved is covered by unit prices contained in the Contract Documents (subject to the provisions of Paragraphs 11.9.1. through 11.9.3., inclusive).

11.3.2. By mutual acceptance of a lump sum (which may include an estimate of overhead and profit not necessarily in accordance with Paragraph 11.6.2.1.) which, unless otherwise approved by the ENGINEER, will be supported by a detailed breakdown in accordance with Paragraphs 11.4 and 11.5.

11.3.3. On the basis of the Cost of the Work (determined as provided in Paragraphs 11.4. and 11.5.) plus a CONTRACTOR's Mark-Up for overhead and profit (determined as provided in Paragraphs 11.6. and 11.7.).

11.3.4. The CONTRACTOR has 20 days to submit the final pricing to the OWNER for proposed Change Orders once the Work is complete. If the CONTRACTOR fails to meet this timeframe for pricing submittal, the OWNER may reject the pricing and payment requests for the Work. It is the OWNER's sole discretion to provide additional time for pricing the Work which will be done through written notification.

Cost of The Work:

11.4. The term Cost of the Work means the sum of costs necessarily incurred and paid by the CONTRACTOR in the proper performance of the Work. Except as otherwise may be agreed to, in writing, by the ENGINEER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.5:

11.4.1. Payroll costs for employees in the direct employ of the CONTRACTOR in the performance of the Work under schedules of job classifications agreed upon by the ENGINEER and the CONTRACTOR. The CONTRACTOR's Mark-Up shall be limited to 10%. Payroll costs for employees not employed full-time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but shall not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereunto at actual cost. Workers' compensation shall be net of premium discounts, dividends, and rebates. Such employees shall include superintendents and foremen at the site. The expenses of performing Work after regular working hours, on Saturday, Sunday, or legal holidays may not be included unless otherwise agreed to by the CONTRACTOR and the ENGINEER. The cost of training and safety that are directly related to the Project shall be paid. The cost of general training for the advancement of the employee or for the future benefit of the employee and/or the CONTRACTOR and not directly related to the Project shall not be paid. This change applies to other mentions of Paragraph 11.4. in its entirety in the Supplementary Conditions or the Agreement form.

11.4.2. The cost of materials and equipment furnished and incorporated in the Work including the cost of transportation and the storage thereof and Suppliers' field services required in connection therewith. The CONTRACTOR's Mark-Up shall be limited to 10%. Cash discounts shall accrue to the CONTRACTOR, unless the OWNER deposits funds with the CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to the OWNER. Trade discounts, rebates and refunds, and returns from sale of surplus materials and equipment shall accrue to the OWNER, and the CONTRACTOR shall make provisions so that they may be obtained.

11.4.3. Payments shall be made by the CONTRACTOR to the Subcontractors for Work performed by the Subcontractors. The Subcontractor performing the Work shall be paid a mutually acceptable fixed Mark-Up as defined in Subparagraph 11.6.2.2. If required by the ENGINEER, the CONTRACTOR shall obtain competitive Bids from Subcontractors acceptable to the CONTRACTOR and shall deliver such Bids to the ENGINEER who will then determine which Bid(s) will be accepted. If a subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work Plus a Mark-Up, the Subcontractor's Cost of the Work shall be determined in the same manner as the CONTRACTOR's Cost of the Work. Subcontracts shall be subject to the other provisions of the Contract Documents as applicable.

11.4.4. Costs of the CONTRACTOR's Consultants (including, but not limited to, engineers, architects, testing laboratories, surveyors, and accountants) employed for services specifically related to the Work.

11.4.5. Supplemental costs, including the following:

11.4.5.1. The proportion of necessary transportation, travel, and subsistence expenses of the CONTRACTOR's employees incurred in the discharge of duties connected with the Work.

11.4.5.2. Cost, including transportation and maintenance, of materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site, and hand tools not owned by the workers, which are consumed in the performance of the Work and cost less market value of such items used, but not consumed, that remain the property of the CONTRACTOR.

11.4.5.3. Rentals of construction equipment and machinery, and the parts thereof, to the extent they are used in the performance of the Work, whether rented from the CONTRACTOR or others and the costs of transportation, loading, unloading, installation, dismantling, and removal thereof, in accordance with terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

11.4.5.4. Sales, consumer, use, or similar taxes related to the Work, for which the CONTRACTOR is liable, imposed by Laws or Regulations.

11.4.5.5. Deposits lost for causes other than the negligence of the CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by them, or for whose acts any of them may be liable, and royalty payments and costs for permits and licenses.

11.4.5.6. Losses and damages (and related expenses) that are not compensated by insurance or otherwise, to the Work or otherwise reasonably sustained by the CONTRACTOR in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance established by the Owner in accordance with ARTICLE 5), provided they have resulted from causes other than the negligence of the CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by any of them or for whose acts they may be liable. Such losses shall include settlements made with the written consent and approval of the ENGINEER. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining the CONTRACTOR's Mark-Up. However, if any such loss or damage requires reconstruction and the CONTRACTOR is placed in charge thereof, the CONTRACTOR will be paid for services a Mark-Up proportionate to that stated in Paragraph 11.6.2.

11.4.5.7. The cost of utilities, fuel, and sanitary facilities at the site.

11.4.5.8. Cost of premiums for additional Bonds and Insurance required because of changes in the Work and premiums for property insurance coverage within the limits of the deductible amounts established in accordance with ARTICLE 5.

11.5. Except as may be set forth in the documentation establishing the GMP for CMAR and CM/GC Contracts, the term Cost of the Work shall not include any of the following:

11.5.1. Payroll costs and other compensation of the CONTRACTOR's officers, executives, principals (of partnerships and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by the CONTRACTOR whether at the site or in the CONTRACTOR's principal or a branch office for general administration of the Work and not specifically included in the agreed-upon schedule of job classifications referred to in Paragraph 11.4.1. or specifically covered by 11.4.4., all of which are to be considered administrative costs covered by the CONTRACTOR's Mark-Up.

11.5.2. Expenses of the CONTRACTOR's principal and branch offices other than the CONTRACTOR's office at the site.

11.5.3. Any part of the CONTRACTOR's capital expenses, including interest on the CONTRACTOR's capital employed for the Work and charges against the CONTRACTOR for delinquent payments.

11.5.4. Costs due to the negligence of the CONTRACTOR, any Subcontractor, anyone directly or indirectly employed by them, or for whose acts any of them may be liable including, but not limited to, the correction of Defective Work, the disposal of materials or equipment wrongly supplied, and making good any damage to property.

11.5.5. Other overhead or general expense costs of any kind including information technology and general accounting expenses, extended overhead, and the costs of any item not specifically and expressly included in Paragraph 11.4.

CONTRACTOR's Mark-Up:

11.6. Except as may be set forth in the documentation establishing the GMP for a CMAR or CM/GC Contract, the CONTRACTOR's Mark-Up allowed to the CONTRACTOR for overhead and profit shall be one of the following two alternatives:

11.6.1. A mutually acceptable fixed Mark-Up as determined through the negotiation and acceptance of the CMAR or CM/GC Proposal; or

11.6.2. If no fixed Mark-Up is mutually acceptable, a Mark-Up based on the following percentages of the various portions of the Cost of the Work:

11.6.2.1. for costs incurred under Paragraphs 11.4.1. and 11.4.2., the CONTRACTOR's Mark-Up shall be limited to 10%;

11.6.2.2. for costs incurred under Paragraph 11.4.3., the Subcontractor performing the Work shall be paid a mutually acceptable fixed Mark-Up; or, if directed by the ENGINEER, the Cost of the Work plus a maximum of 10% for overhead and profit; this shall be defined as 'Subcontractor Total Payment'. The CONTRACTOR's Mark-Up shall total 5% of the Subcontractor Total Payment. No additional overhead and profit shall be paid to the CONTRACTOR. There shall be no payment of Mark-Ups to intermediate tiers;

11.6.2.3. No additional Mark-Up is allowed for small tools, safety programs, or other similar CONTRACTOR programs or activities. These activities, programs, and their costs are to be included in the Mark-Up or option agreed to above;

11.6.2.4. The amount of credit to be allowed by the CONTRACTOR to the OWNER for any change that results in a net decrease in cost will be the amount of the actual net decrease; and

11.6.2.5. When both additions and credits are involved in any one change, the adjustment in the CONTRACTOR's Mark-Up shall be computed on the basis of the net change in accordance with Paragraphs 11.6.2.1. through 11.6.2.4., inclusive.

11.7. Whenever the cost of any Work is to be determined pursuant to Paragraph 11.4. or 11.5., the CONTRACTOR shall submit to the Construction Project Manager an itemized cost breakdown with supporting data.

Hierarchical Tiers:

11.8. Except as may be set forth in the documentation establishing the GMP for a CMAR or CM/GC Contract, regardless of the number of Subcontractors, (reference 11.6.2.2.), the 5% increase above the Subcontractor's total cost, which includes allowances for overhead and profit, may be applied one time only for each separate Work transaction.

11.9. **Unit Price Work:**

11.9.1. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price shall be deemed to include for Unit Price Work an amount equal to the sum of the established unit prices for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by the CONTRACTOR shall be made in accordance with Paragraph 9.10.

11.9.2. Each unit price shall be deemed to include an amount considered by the CONTRACTOR to be adequate to cover the CONTRACTOR's overhead and profit for each separately identified item.

11.9.3. If the actual quantity of any item of Unit Price Work varies by more than 25% above or below the estimated quantity, an equitable adjustment in the Contract Price shall be made upon the request of the CONTRACTOR or the OWNER. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above 125% or below 75% of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the CONTRACTOR may request, in writing, an extension of time in accordance with ARTICLE 12.

ARTICLE 12--CHANGE OF CONTRACT TIME

12.1. The Contract Time, or Milestones, may only be changed by a Change Order or an Amendment. Any Claim for an extension or shortening of the Contract Time (or Milestones) shall be made as set forth in ARTICLE 16.

12.2. Time is of the essence with regard to time limits stated in the Contract Documents.

12.3. Where the CONTRACTOR is prevented from completing any part of the Work within the Contract Time, or Milestones, due to delay beyond the control of the CONTRACTOR, the Contract Time, or Milestones, will be extended in an amount equal to the time lost due to such delay if the CONTRACTOR requests a Change Order as set forth in ARTICLE 10.5.2. Delays beyond the control of the CONTRACTOR include, but are not limited to, acts or neglect by the OWNER or other contractors performing other Work as contemplated by ARTICLE 7, fires, floods, epidemics, unusually severe weather conditions in excess of those provided for in the Specifications, or acts of God. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of the CONTRACTOR. An extension of Contract Time shall be the CONTRACTOR's sole and exclusive remedy for delay unless acts or omissions of the OWNER or the ENGINEER caused said delay. In no event shall the OWNER be liable to the CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any Surety for or employee or agent of any of them, for damages not actually incurred or for damages arising out of or resulting from (i) delays not caused by the OWNER or the ENGINEER or (ii) delays beyond the control of both parties including, but not limited to, fires, floods, epidemics, unusually severe weather conditions, acts of God, or acts or neglect by utility owners or other contractors performing other Work as contemplated by ARTICLE 7.

In addition to the requirements of ARTICLE 16, any CONTRACTOR Claim for an extension of Contract Time due to unusually severe weather conditions shall be in accordance with the requirements of SECTION 01 32 16.01 or SECTION 01 32 16.02 – Cost Loaded Schedule.

ARTICLE 13--TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

Notice of Defects:

13.1. The ENGINEER will deliver to the CONTRACTOR prompt notice of known defects in the Work. Defective Work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article.

Access to Work:

13.2. The ENGINEER and other representatives of the OWNER, including the OWNER's Consultant, testing agencies, and governmental agencies with jurisdictional interests shall have access to the Work at reasonable times for their observation, inspection, and testing. The CONTRACTOR shall provide proper and safe conditions for such access.

Tests and Inspections:

13.3. The CONTRACTOR shall give the ENGINEER timely notice, at least 48 hours unless otherwise specified in the Contract Documents, of readiness of the Work for required inspections, tests, or approvals, unless the ENGINEER, in writing, deems that additional time for notice is required.

13.4. If the Laws or Regulations of any public body having jurisdiction require any Work (or a part thereof) to specifically be inspected, tested, or approved, the CONTRACTOR shall assume full responsibility, paying costs in connection therewith and furnishing the ENGINEER with the required certificates of inspection, testing, or approval. The CONTRACTOR shall also be responsible for and shall pay costs in connection with any inspection or testing required in connection with the ENGINEER's acceptance of a Supplier of materials or equipment proposed to be incorporated in the Work or of materials or equipment submitted for approval prior to the CONTRACTOR's purchase thereof for incorporation in the Work. The cost of inspections, tests, and approvals, in addition to those listed, which are required by the Contract Documents, will be paid by the OWNER (unless otherwise specified).

13.5. Inspections, tests, or approvals other than those required by the Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to the ENGINEER and the CONTRACTOR. Materials testing by the ENGINEER is for the benefit of the OWNER and is intended for verifying compliance with the Contract Documents. Any additional testing shall be performed by the CONTRACTOR.

13.6. Neither observations by the ENGINEER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR's obligations to perform the Work in accordance with the Contract Documents.

Uncovering Work:

13.7. If any Work (including the Work of others) that is to be inspected, tested, or approved is covered without the written authorization of the ENGINEER, it shall be uncovered for observation if requested by the ENGINEER. Such uncovering and subsequent replacement shall be at the CONTRACTOR's expense unless the CONTRACTOR has given the Construction Project Manager timely notice of the CONTRACTOR's intention to cover the Work and the ENGINEER has failed to act with reasonable promptness in response to such notice. The cost for compensating the ENGINEER for any additional professional services required including retesting and as specified in Paragraph 13.10, shall be at the CONTRACTOR's sole expense, if:

a. The exposed Work or material proves to be defective, or

b. The exposed Work or material was placed without authority or due notice to the ENGINEER.

If the exposed Work proves to be acceptable and the CONTRACTOR had performed the original Work with the authority of and due notice to the ENGINEER, payment will be made by OWNER as extra Work for costs associated with the uncovering, removing, and restoration and the Contract Time will be adjusted.

Where Work is required to be performed on any facility of a public agency, railroad, or utility, or to the satisfaction of any Federal, State, County, or Municipal Agency, their representatives shall be permitted to inspect the Work when the CONTRACTOR is advised by the ENGINEER to permit them to do so. The CONTRACTOR agrees that such inspection shall not make such representatives a party to the Contract, nor shall it constitute an interference with the rights of the OWNER or the CONTRACTOR.

13.8. If the ENGINEER has issued a written authorization allowing the CONTRACTOR's written request for the covering of Work (including the Work of others) in accordance with the provisions of Paragraph 13.7., and the ENGINEER later considers it necessary or advisable that said covered Work be observed by the ENGINEER or inspected or tested by others, the CONTRACTOR, at the ENGINEER's written request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as the ENGINEER may require, that portion of the Work in question, furnishing necessary labor, material, and equipment. If it is found that such Work is Defective, the CONTRACTOR shall bear direct, indirect, and consequential costs of such uncovering, exposure, observation, inspection, testing, and of satisfactory reconstruction (including, but not limited to, charges of engineers, architects, attorneys, and other professionals), and the OWNER shall be entitled to an appropriate decrease in the Contract Price; if the parties are unable to agree as to the amount thereof, the ENGINEER will make the determination and the CONTRACTOR may dispute such through a Claim as provided for in ARTICLE 16. If, however, such Work is not found to be Defective, the CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction; if the parties are unable to agree as to the amount or extent thereof, the CONTRACTOR may make a Claim as provided for in ARTICLE 16.

OWNER May Stop The Work:

13.9. If the Work is Defective, or the CONTRACTOR fails to supply sufficient skilled workers, suitable materials, or equipment or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, the ENGINEER may order the CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated. However, this right of the OWNER to stop the Work shall not give rise to any duty on the part of the OWNER, acting through the ENGINEER, to exercise this right for the benefit of the CONTRACTOR or any other party.

Correction or Removal of Defective Work:

13.10. If required by the ENGINEER, the CONTRACTOR shall promptly, as directed, either correct Defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by the ENGINEER, remove it from the site and replace it with non-Defective Work. The CONTRACTOR shall bear direct, indirect, and consequential costs of such correction or removal (including, but not limited to, charges of engineers, architects, attorneys, and other professionals) made necessary thereby. These charges will be deducted from the Contract by deductive Change Order.

Defective Work also includes Work done beyond lines and grades shown in the Drawings or established by the ENGINEER, or extra Work and materials furnished without written approval of the ENGINEER will be considered Defective Work or unauthorized Work as applicable. Such Work shall be at the CONTRACTOR's risk and sole expense and may be rejected, even if the Work has been inspected or a progress estimate is made for payment.

Upon order of the ENGINEER, such Work or material shall immediately be remedied, removed, replaced, or disposed of and the costs, including retesting costs as applicable, associated with such Work shall be at the CONTRACTOR's sole expense. Such laboratory retesting costs of replaced or reconstructed Work or material will be charged to the CONTRACTOR at $200 per test to cover site visit and retest expenses. Such tests could include field soil density reading, concrete pavement coring, asphalt pavement coring, soil/aggregate sieve analysis, moisture-density curve, L. A. abrasion, soundness, organic content, epoxy pull out test, asphalt concrete sieve analysis, asphalt concrete binder content, and asphalt concrete air void analysis (V_A).

Failure on the part of the ENGINEER to reject Defective Work or unauthorized Work shall not release the CONTRACTOR from its contractual obligations, be constructed to mean acceptance of such Work or material by the OWNER, or, after the Completion Date, bar the OWNER from recovering damages or obtaining such other remedies as may be permitted by law.

No adjustment in the Contract Time or compensation will be allowed because of delays in the performance of the Work as a result of correcting Defective Work or unauthorized Work.

13.11. **One-Year Correction Period:**

13.11.1. If any Work is found to be Defective within one year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations, by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents, the CONTRACTOR shall promptly, without cost to the OWNER and in accordance with the OWNER's written instructions, (i) correct such Defective Work, or, if it has been rejected by the OWNER, remove it from the site and replace it with Work that is not Defective, and (ii) satisfactorily correct or remove and replace any damage to other work or the work of others resulting therefrom. If the CONTRACTOR does not promptly comply with the terms of such instructions, or in the event of an emergency where delay would cause serious risk of loss or damage, the OWNER may have the Defective Work corrected or removed and replaced, and Claims, costs, losses, and damages caused by or resulting from such removal and replacement (including, but not limited to, costs of repair or replacement of the work of others) shall be paid by the CONTRACTOR.

13.11.2. In special circumstances where a particular item of equipment is placed in continuous service before the Substantial Completion of the Work, the correction period for that item may run from an earlier date if so provided in the Specifications or by Amendment.

13.11.3. Where Defective Work (and damage to other Work resulting therefrom) has been corrected, removed, or replaced, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

13.11.4. Where notification of Defective Work has been given prior to the expiration of the one-year warranty period, and correction is not performed by the date of expiration, the CONTRACTOR shall be held responsible for the correction of such defects.

Acceptance of Defective Work:

13.12. If the ENGINEER (prior to recommendation of final payment) prefers to accept the Work instead of requiring the correction or removal and replacement of Defective Work, the ENGINEER may do so. The CONTRACTOR shall bear reasonable direct, indirect, and consequential costs attributable to the ENGINEER's evaluation of and determination to accept such Defective Work (such costs to be approved by the ENGINEER as to reasonableness and to include, but not be limited to, charges of engineers, architects, attorneys, and other professionals). If any such acceptance occurs prior to the final payment, the ENGINEER will provide written notice of said costs to the CONTRACTOR and prepare a proposed Change Order that incorporates the necessary revisions in the Contract Documents and decreases the Contract Price accordingly. If the parties are unable to agree as to the amount thereof, these charges will be deducted from the Contract by deductive Change Order, and the CONTRACTOR may initiate a Claim thereafter as set forth in ARTICLE 16. If the acceptance occurs after the final payment, then an appropriate amount shall be paid by the CONTRACTOR to the OWNER.

OWNER May Correct Defective Work:

13.13. If the CONTRACTOR fails to correct Defective Work or to remove and replace rejected Work as required by the ENGINEER in accordance with Paragraph 13.10., fails to perform the Work in accordance with the Contract Documents, or fails to comply with any other provision of the Contract Documents within a reasonable time after receiving written notice from the ENGINEER, the OWNER, acting through the ENGINEER, may, after 7 days written

notice to the CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this Paragraph the OWNER will proceed expeditiously. To the extent necessary to complete corrective and remedial action, the OWNER may exclude the CONTRACTOR from all or part of the site, take possession of all or part of the Work, and suspend the CONTRACTOR's services related thereunto. In addition, the OWNER may take possession of the CONTRACTOR's tools, appliances, construction equipment, and machinery at the site and incorporate in the Work materials and equipment stored at the site or for which the OWNER has paid the CONTRACTOR but which are stored elsewhere. The CONTRACTOR shall allow the OWNER, the OWNER's representatives, agents, and employees such access to the site as may be necessary to enable the OWNER to exercise the rights and remedies under this Paragraph. Direct, indirect, and consequential costs of the OWNER in exercising such rights and remedies shall be charged against the CONTRACTOR and a Change Order will be issued by the ENGINEER incorporating the necessary revisions in the Contract Documents with respect to the Work. The OWNER shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the decrease, these charges will be deducted from the Contract by deductive Change Order, and the CONTRACTOR may initiate a Claim thereafter as set forth in ARTICLE 16. Such direct, indirect, and consequential costs will include, but not be limited to, charges of engineers, architects, attorneys, and other professionals, court proceedings and other alternative dispute resolution costs, and costs of repair and replacement of the Work of others that is destroyed or damaged by the correction, removal, or replacement of the CONTRACTOR's Defective Work. The CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by the OWNER of its rights and remedies hereunder.

ARTICLE 14--PAYMENTS TO CONTRACTOR AND COMPLETION

Progress Payments:

14.1. On or before the 20th day of each calendar month, submit to the Construction Project Manager a Draft Partial Payment Application on the OWNER's template. This Draft shall be based upon the CLS as provided in Paragraph 2.6.1. Progress payments relating to Unit Price Work will be based on the number of units completed. This Draft shall be based upon the quantity of Work performed and completed during the payment period, which is defined as the 21st day of the preceding calendar month through the end of the 20th day of the current calendar month. The Draft shall also conform to Paragraph 14.2.1.

14.2. If the Construction Project Manager agrees with the CONTRACTOR's Draft Partial Payment Application, the ENGINEER will, within 10 days after the receipt of such Draft, issue a preliminary approval or denial of such Draft.

Preliminary approval by the ENGINEER of the Draft Partial Payment Application will occur as follows. The Construction Project Manager will fill out and sign two duplicate, preliminary copies of the Partial Payment Application form and attach any supporting documentation required by the Contract Documents that the CONTRACTOR has provided to the Construction Project Manager. The Construction Project Manager will then present the duplicate Partial Payment Applications to the CONTRACTOR for the CONTRACTOR's signature. The CONTRACTOR shall sign both copies of the Partial Payment Application and return them to the Construction Project Manager for final approval and processing of payment by the ENGINEER. The CONTRACTOR shall sign the duplicates of the Partial Payment Application prior to the 30th day of each month to ensure timely payment. Payment to the CONTRACTOR typically occurs on the third Thursday of each calendar month.

Preliminary denial of the CONTRACTOR's Draft Partial Payment Application and any denial of final approval of the Partial Payment Application by the ENGINEER will occur as follows. The ENGINEER will provide to the CONTRACTOR a written explanation of the portion denied and the basis for such denial which will be based upon the reasons set forth in this Article. The CONTRACTOR may then accept payment for approved portions while electing to resubmit any denied portions or initiate a Claim for denied portions as provided in ARTICLE 16.

Necessary Documentation:

14.2.1. The CONTRACTOR's Draft Partial Payment Application shall be accompanied by the documentation specified herein.

If payment is requested for materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at a bonded warehouse agreed to in writing, the Partial Payment Application shall be accompanied by evidence of the OWNER's title to the material and equipment and evidence of sufficient insurance. (Note: Payments for such materials and equipment shall be at the sole discretion of the ENGINEER, shall be based only upon the actual cost of the materials and equipment to the CONTRACTOR as listed in the CLS, and shall not include any overhead or profit to the CONTRACTOR.)

Each Partial Payment Application shall be accompanied by the CONTRACTOR's updated CLS and other data specified in the Contract Documents or reasonably required by the ENGINEER.

ENGINEER'S Review and Approval of Partial Payment Applications:

14.3. The ENGINEER's approval of any payment will constitute a representation by the ENGINEER, based on the ENGINEER's on-site observations of the Work in progress and on the ENGINEER's review of the Partial Payment Application and the accompanying data and schedules, that the Work has progressed to the point indicated, that, to the best of the ENGINEER's knowledge, information, and belief, the quality of the Work is in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, subject to the results of any subsequent tests called for in the Contract Documents, subject to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.10., and subject to any other qualifications stated in the recommendation), and that the CONTRACTOR is entitled to payment of the amount recommended. However, by approving any such payment, the ENGINEER will not thereby be deemed to have represented that exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work beyond the responsibilities specifically assigned to the ENGINEER in the Contract Documents or that there may not be other matters or issues between the parties that might entitle the CONTRACTOR to be paid additionally by the OWNER or the OWNER to withhold payment or receive a credit from the CONTRACTOR.

14.4. The ENGINEER's recommendation of a final Partial Payment Application will constitute an additional representation by the ENGINEER to the OWNER that the conditions indicated in Paragraph 14.13. have been fulfilled.

14.5. The ENGINEER may refuse to approve the whole payment, or any part thereof, if, in the ENGINEER's opinion, it would be incorrect to make the representations to the OWNER that are referenced in the preceding Paragraphs. The ENGINEER may also refuse to approve any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, may nullify any such payment previously approved to the extent necessary to protect the OWNER from loss because:

14.5.1. the Work is Defective, or the completed Work has been damaged requiring correction or replacement thereof;

14.5.2. the Contract Price has been reduced by Amendment or Change Order;

14.5.3. the OWNER has been required to correct Defective Work or complete Work in accordance with Paragraph 13.13.;

14.5.4. of the occurrence of any of the events enumerated in Paragraphs 15.2.1. through 15.2.9., inclusive;

14.5.5. the ENGINEER has reason to believe that a Claim or lien relating to the Work has been or will be filed against the CONTRACTOR;

14.5.6. the ENGINEER has reason to believe insufficient competitive pricing was utilized in the development of the Partial Payment Application.

The ENGINEER may also refuse to approve a Partial Payment Application because Claims have been made against the OWNER and/or the CONTRACTOR on account of the CONTRACTOR's performance or furnishing of the Work, liens have been filed in connection with the Work, or there are other items entitling the OWNER to a set-off against the amount for which the CONTRACTOR applied. However, the OWNER will give the CONTRACTOR immediate written notice stating the reasons for such action.

Retainage:

14.6. Retainage from progress payments shall be withheld as stated in the Agreement. Any such funds so retained shall not be subject to substitution by the CONTRACTOR with securities or any arrangements involving an escrow or custodianship, except as allowed by Colorado Revised Statutes, § 38-26-108, et seq. The OWNER further reserves the right to apply retainage not subject to verified Claims of Subcontractors and Suppliers to any liquidated damages due to the OWNER and to 150% of the costs estimated by the ENGINEER to remedy incomplete or Defective Work. By executing the Agreement form, the CONTRACTOR expressly waives its right to any entitlement to the benefits of the provisions of Colorado Revised Statutes, § 24-91-101, et seq.

CONTRACTOR's Warranty of Title:

14.7. The CONTRACTOR warrants and guarantees that title to Work, materials, and equipment covered in any Partial Payment Application, whether incorporated in the Project or not, shall pass to the OWNER no later than the time of payment and shall be free and clear of liens.

Substantial Completion:

14.8. When the CONTRACTOR considers the entire Work ready for its intended use, the CONTRACTOR shall notify the Construction Project Manager, in writing, that the entire Work is substantially complete (except for items specifically listed by the CONTRACTOR as incomplete) and shall request that the ENGINEER issue a letter certifying Substantial Completion.

To be considered substantially complete the following conditions shall be met:

a. The OWNER shall have full and unrestricted use and benefit of the facilities, both from an operational and safety standpoint including:

1) The degree of completion of the Project's operating facilities or systems is sufficient to provide the OWNER the full-time, uninterrupted, continuous beneficial operation of the Work.

2) All required functional, performance, acceptance, and startup testing has been successfully demonstrated for components, devices, equipment, instrumentation, and control to the satisfaction of the ENGINEER in accordance with the requirements of the Specifications.

3) Required inspections have been completed and any identified conditions corrected.

b. Only minor incidental Work, replacement of temporary substitute facilities, or corrective or repair Work remains to reach Final Completion of the Work.

c. Conformance with training service requirements.

d. Correction of state, local, and other regulatory agencies defective work list.

e. Submittals have been received and approved by the ENGINEER. These include, but are not limited to:

1) Record documents.

2) Operation and maintenance manuals including service and maintenance agreements.

3) Equipment data forms.

4) Manufacturer's certificates of proper installation.

5) Factory test reports.

f. All special accessories have been provided that are required to place each item of equipment in full operation. These special accessory items include, but are not limited to, specified spare parts, test equipment, adequate oil and grease or other lubrication, air filters, light bulbs, fuses, special tools, valve operators, and other expendable items required for the startup and operation of the operating facilities or systems as a whole.

g. All additional warranty or insurance coverage requirements have been provided.

The CONTRACTOR's request shall list the specific items of Work regarding the conditions listed above that remain to be completed to reach Final Completion.

Within a reasonable time thereafter, the CONTRACTOR and the ENGINEER will make an inspection of the Work to determine the status of completion. If the ENGINEER does not consider the Work to be substantially complete, the ENGINEER will notify the CONTRACTOR, in writing, stating the reasons for such; any disputes regarding this determination shall be resolved as set forth in ARTICLE 16.

If, after this inspection, the ENGINEER does not consider the Work substantially complete, the ENGINEER will, by written notice, so notify the CONTRACTOR giving the reasons therefore.

If the ENGINEER considers the Work to be substantially complete, the ENGINEER will prepare and deliver to the CONTRACTOR a letter certifying Substantial Completion, which shall fix the date of Substantial Completion. At the time of delivery of the letter certifying Substantial Completion, the ENGINEER will deliver to the CONTRACTOR a written statement as to the division of responsibilities pending final payment between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities, insurance, and warranties. The ENGINEER's letter will be binding on the OWNER and the CONTRACTOR until final payment.

Upon receipt of written notice concurring in or denying Substantial Completion, whichever is applicable, the CONTRACTOR shall pursue vigorously, diligently, and without unauthorized interruption, the Work necessary to reach Substantial and/or Final Completion. The CONTRACTOR shall provide the ENGINEER with a revised critical path schedule indicating when the CONTRACTOR expects to reach Substantial and/or Final Completion of the Work.

The above process shall be repeated until the ENGINEER establishes the Substantial Completion Date.

The ENGINEER may also establish the Substantial Completion Date unilaterally.

14.9. The OWNER shall have the right to exclude the CONTRACTOR from certain portions of the Work after the date of Substantial Completion; however, the OWNER will allow the CONTRACTOR reasonable access to complete the remainder of the Work.

Partial Utilization:

14.10. Use by the OWNER of any finished part of the Work, which has specifically been identified in the Contract Documents or which the ENGINEER and the CONTRACTOR agree constitutes a separately functioning and usable part of the Work that can be used by the OWNER without significant interference with the CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of the Work subject to the following:

14.10.1. The ENGINEER may, at any time, request that the CONTRACTOR, in writing, permit the OWNER to use any such part of the Work that the ENGINEER believes to be ready for its intended use and substantially complete. If the CONTRACTOR agrees, the CONTRACTOR shall certify to the ENGINEER that said part of the Work is substantially complete and request that the ENGINEER issue a letter certifying Substantial Completion for that part of the Work. The CONTRACTOR may, at any time, notify the ENGINEER, in writing, that the CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request that the ENGINEER issue a letter certifying Substantial Completion for that part of the Work. Within a reasonable time after either party makes such a request, the CONTRACTOR and the ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If the ENGINEER does not consider that part of the Work to be substantially complete, the ENGINEER will notify the CONTRACTOR, in writing, stating the reasons for such. If the ENGINEER considers that part of the Work to be substantially complete, the provisions of Paragraphs 14.9. and 14.10. will apply with respect to the letter certifying Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereunto. Prior to the Substantial Completion of Work, the OWNER reserves the right to refuse to grant the CONTRACTOR's requests for letters of Substantial Completion for portions of the Work that the CONTRACTOR considers substantially complete.

14.10.2. The ENGINEER may, at any time, request that the CONTRACTOR, in writing, permit the OWNER to take over the operation of any such part of the Work although it is not substantially complete. Within a reasonable time thereafter, the CONTRACTOR and the ENGINEER will make an inspection of that part of the Work to determine its status of completion and the ENGINEER will prepare a list of the items remaining to be completed or corrected thereon before final payment. If the CONTRACTOR does not object, in writing, to the ENGINEER, that such part of the Work is not ready for separate operation by the OWNER, the ENGINEER will finalize a punchlist of items to be completed or corrected and will deliver such punchlist to the CONTRACTOR together with a written statement as to the division of responsibilities pending final payment between the OWNER and the CONTRACTOR with respect to security, operation, safety, maintenance, utilities, insurance, warranties, and guarantees for that part of the Work which will become binding upon the OWNER and the CONTRACTOR at the time when the OWNER takes over such operation (unless they shall have otherwise agreed, in writing, and so informed the ENGINEER). During such operation and prior to Substantial Completion of such part of the Work, the OWNER will allow the CONTRACTOR reasonable access to complete or correct such items on said list and to complete other related Work.

14.10.3. No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of ARTICLE 5 in respect to property insurance.

Final Inspection and Final Completion:

14.11. Upon written notice from the CONTRACTOR that the entire Work or an agreed-upon portion thereof is complete, the ENGINEER will make a final inspection with the CONTRACTOR and will notify the CONTRACTOR, in writing, of particulars in which this inspection reveals that the Work is incomplete or Defective. The CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

The final inspection and Final Completion shall include final cleanup as stated in the Specifications, providing the ENGINEER with all required Submittals and operation and maintenance manuals, and completing operational testing, associated documentation, and all extra Work ordered by the ENGINEER as included in the Contract. If the ENGINEER believes a written release from a private property owner is being arbitrarily withheld, the ENGINEER may, at its sole discretion, accept that portion of the Work involved.

If action to correct the listed deficiencies is not initiated within 7 days after receipt of the written notice listing the deficiencies, the ENGINEER may, upon written notice to the CONTRACTOR, correct Defective Work in accordance with ARTICLE 13.13. The CONTRACTOR will not be allowed an extension of Contract Time because of a delay in the performance of the Work attributable to the exercise of the ENGINEER's right hereunder.

Upon correction of all deficiencies, the ENGINEER will notify the CONTRACTOR and the OWNER, in writing, of the date upon which the Work was considered finally complete. That date shall constitute the Final Completion Date of the Contract but shall not imply all the obligations of the CONTRACTOR under the Contract have been fulfilled.

Application for Final Payment:

14.12. After the CONTRACTOR has completed all corrections to the satisfaction of the ENGINEER and delivered all maintenance and operating instructions, occupancy permits, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents (as provided in Paragraph 6.18.), and other documents and permits as required by the Contract Documents, and after the ENGINEER has indicated that the Work is acceptable (subject to the provisions of Paragraph 14.16.), the CONTRACTOR may make application for final payment following the procedure for progress payments set forth above. The application for final payment shall be accompanied by the documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to the ENGINEER) of liens and verified Claims arising out of or filed in connection with the Work. In lieu thereof and as approved by the ENGINEER, the CONTRACTOR may furnish receipts or releases in full and an affidavit from the CONTRACTOR that the releases and receipts include labor, services, material, and equipment for which a Claim could be filed and that payrolls, material, and equipment bills and other indebtedness connected with the Work for which the OWNER or the OWNER's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish a release or receipt in full, the CONTRACTOR may furnish a Bond or other collateral satisfactory to the OWNER to indemnify the OWNER against any Claim. A Final Payment Release form is included in the Contract Documents for the purposes of satisfying these requirements.

Final Payment and Acceptance:

14.13. If the ENGINEER is satisfied that the Work has been completed, on the basis of the ENGINEER's observation of the Work during construction and final inspection and the ENGINEER's review of the application for final payment and accompanying documentation as required by the Contract Documents, and the CONTRACTOR's other obligations under the Contract Documents have been fulfilled, the ENGINEER will present the final Partial Payment Application to the OWNER for payment. Thereupon, the ENGINEER will give written notice to the CONTRACTOR that the Work is acceptable subject to the provisions of Paragraph 14.16. Otherwise, the ENGINEER will deny payment according to the procedures set forth above. After presentation to the OWNER of the Application and the accompanying documentation and with the ENGINEER's recommendation and notice of acceptability, the amount recommended by the ENGINEER will be paid by the OWNER to the CONTRACTOR. Final payment will be made in accordance with the law and particularly in compliance with Colorado Revised Statutes, § 38-26-107.

14.14. If Final Completion of the Work is significantly delayed through no fault of the CONTRACTOR and if the ENGINEER so confirms, the OWNER will, upon receipt of the CONTRACTOR's application for final payment, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed, as determined and accepted by the ENGINEER. If the remaining balance to be held by the OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in Paragraph 5.1., the written consent of the Surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the CONTRACTOR to the ENGINEER with the Partial Payment Application. Any such payment will be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

CONTRACTOR's Continuing Obligation:

14.15. The CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. Neither approval of any progress payment, nor recommendation for final payment by the ENGINEER, nor the issuance of a letter certifying Substantial Completion, nor any payment by the OWNER to the CONTRACTOR under the Contract Documents, nor any use or occupancy of the Work or any part thereof by the OWNER, nor any act of acceptance by the OWNER nor any failure to do so, nor any review and approval of a Shop Drawing or Sample submission, nor the issuance of a notice of acceptability by the ENGINEER pursuant to Paragraph 14.14., nor any correction of Defective Work by the OWNER will constitute an acceptance of Work not in accordance with the Contract Documents or a release of the CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents (except as provided in Paragraph 14.16.).

Waiver of Claims:

14.16. The making and acceptance of final payment will constitute both:

14.16.1. A waiver of Claims by the OWNER against the CONTRACTOR, except Claims arising from unsettled liens, arising from Defective Work appearing after final inspection pursuant to Paragraph 14.13., or arising from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, but it shall not constitute a waiver by the OWNER of any rights in respect to the CONTRACTOR's continuing obligations under the Contract Documents or of any Claims previously made, in writing, against the CONTRACTOR that are still unsettled; and

14.16.2. A waiver of Claims by the CONTRACTOR against the OWNER other than those previously made, in writing, and still unsettled.

ARTICLE 15--SUSPENSION OF WORK AND TERMINATION

OWNER May Suspend Work:

15.1. The OWNER may, acting through the ENGINEER, at any time and without cause, suspend the Work, or any portion thereof, for a period of not more than 90 days by notice, in writing, to the CONTRACTOR, which will fix the date on which Work will be resumed. The CONTRACTOR shall resume the Work on the date so fixed. The CONTRACTOR may be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if the CONTRACTOR makes an approved Claim therefor as provided in ARTICLE 16.

OWNER May Terminate Work:

15.2. The OWNER may terminate Work by the CONTRACTOR for cause upon the occurrence of any one or more of the following events:

15.2.1. If the CONTRACTOR commences a voluntary case under any chapter of the Bankruptcy Code (Title 11, United States Code), as now or hereafter in effect, or if the CONTRACTOR takes any equivalent or similar action by filing a petition or otherwise under any other federal or state law in effect at such time relating to bankruptcy or insolvency;

15.2.2. If a petition is filed against the CONTRACTOR under any chapter of the Bankruptcy Code as now or hereafter in effect at the time of filing, or if a petition is filed seeking any such equivalent or similar relief against the CONTRACTOR under any other federal or state law in effect at the time relating to bankruptcy or insolvency;

15.2.3. If the CONTRACTOR makes a general assignment for the benefit of creditors;

15.2.4. If a trustee, receiver, custodian, or agent of the CONTRACTOR is appointed under applicable law or under Contract, whose appointment or authority to take charge of property of the CONTRACTOR is for the purpose of enforcing a lien against such property or for the purpose of general administration of such property for the benefit of the CONTRACTOR's creditors;

15.2.5. If the CONTRACTOR admits, in writing, an inability to pay its debts generally as they become due;

15.2.6. If the CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficiently skilled workers or suitable materials or equipment or failure to adhere to the construction schedule established under Paragraph 2.9. as revised from time to time);

15.2.7. If the CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;

15.2.8. If the CONTRACTOR disregards the authority of the ENGINEER; or

15.2.9. If the CONTRACTOR otherwise violates in any substantial way any provisions of the Contract Documents.

The OWNER may, after giving the CONTRACTOR and Surety 7 days written notice and to the extent permitted by Laws or Regulations, terminate Work by the CONTRACTOR, exclude the CONTRACTOR from the site and take possession of the Work and of the CONTRACTOR's tools, appliances, construction equipment, and machinery at the site and use the same to the full extent they could be used by the CONTRACTOR (without liability to the CONTRACTOR for trespass or conversion), incorporate in the Work materials and equipment stored at the site or for which the OWNER has paid the CONTRACTOR but are stored elsewhere and finish the Work as the OWNER may deem expedient. In such case, the CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds the direct, indirect, and consequential costs of completing the Work (including, but not limited to, reasonable charges of engineers, architects, and other professionals and court costs) such excess will be paid to the CONTRACTOR. If such costs exceed such unpaid balance, the CONTRACTOR shall pay the difference to the OWNER. Such costs incurred by the OWNER will be incorporated in a Change Order, but when exercising any rights or remedies under this Paragraph, the OWNER shall not be required to obtain the lowest price for the Work performed.

Where the CONTRACTOR's services have been so terminated by the OWNER, the termination shall not affect any rights or remedies of the OWNER against the CONTRACTOR then existing or that may thereafter accrue. Any retention or payment of funds due to the CONTRACTOR by the OWNER shall not release the CONTRACTOR from liability. Where the CONTRACTOR's services have been terminated by the OWNER and the OWNER has declared the CONTRACTOR to be in default pursuant to the performance bond, if it is determined that the OWNER's declaration of default and/or termination was invalid or that the CONTRACTOR's delay was excusable, then said termination will be deemed an OWNER termination pursuant to Paragraph 15.3, except that the CONTRACTOR will not be paid consequential costs.

15.3. Upon 7 days written notice to CONTRACTOR, the OWNER may terminate Work by the CONTRACTOR without cause. In such case, the CONTRACTOR shall be paid for all Work executed and any reasonable expense sustained plus reasonable termination expenses which will include, but not be limited to, direct and indirect costs.

CONTRACTOR May Suspend or Terminate Work:

15.4. If through no act or fault of the CONTRACTOR, the Work is suspended by the OWNER, the Work is suspended under an order of court or other public authority, or the ENGINEER persistently fails to act in accordance with the payment procedures set forth in ARTICLE 14 for a period of more than 90 days, then the CONTRACTOR may, upon 7 days written notice to the OWNER through the Construction Project Manager, terminate Work and recover from the OWNER payment for Work executed and any expense reasonably sustained plus reasonable termination expenses which shall include, but not be limited to, direct and indirect costs. The provisions of this Paragraph shall not relieve the CONTRACTOR of the obligation to carry on the Work in accordance with the construction schedule and without delay during disputes and disagreements with the OWNER.

ARTICLE 16--CLAIMS AND DISPUTES

Claims and disputes arising hereunder shall be resolved as set forth below. The rights and remedies of the OWNER hereunder are in addition to and separate from the provisions of Chapter 8 of ARTICLE 20 of Title 13, Colorado Revised Statutes, as they may be amended.

16.1. **Sole Claims Process**

It is expressly agreed that the following process is the sole means of preserving the parties' respective rights and Claims under the Contract. Although other communications related to issues during the Work are also likely to occur, they cannot waive the provisions of this Article, which indicate the only dispute resolution mechanism for Claims, regardless of the theory of entitlement asserted by the parties, Subcontractors, or Suppliers.

Failure of the CONTRACTOR to meet the requirements of this Article in a timely and complete manner shall constitute a waiver of remedies and related rights and Claims, either by administrative review or by any other action at law or equity.

Pending resolution of any Claim, the parties shall proceed diligently with performance of the Contract. The CONTRACTOR's failure to proceed with the Work shall be considered a breach of the Contract and/or grounds for the suspension or termination of the Contract.

16.2. **Notice of Intent to Submit Claim**

If the CONTRACTOR has complied with the requirements herein, and if the CONTRACTOR receives and disagrees with a decision regarding the issuance of a requested Amendment, Change Order, Field Order, or Work Change Directive regarding an equitable adjustment in compensation or time, regarding liquidated damages or other charges, or regarding any other event that may give rise to a Claim under the Contract, and the CONTRACTOR intends to submit a Claim therefor, the CONTRACTOR shall submit to the Construction Project Manager a written Notice of Intent to Submit Claim. The Notice of Intent to Submit Claim shall be clearly titled as such, signed, and dated. If the CONTRACTOR has previously submitted such a Notice, subsequent notices shall be numbered sequentially: "Second Notice of Intent to Submit Claim," etc. The Notice of Intent to Submit Claim shall also contain, at a minimum, the following information, clearly designated:

- Board Contract Number and Project Name;
- Date of the event giving rise to the Claim;
- A description of the Claim and the events giving rise to the Claim including the original request and related decisions or denials;
- The reasons why the CONTRACTOR believes its request is appropriate;
- An accounting, including documentation, or estimate of additional costs associated with the Claim; (if an estimate is provided, documentation shall be provided with the Claim as described below); and
- The CONTRACTOR's plan for mitigating costs or delays associated with the Claim.

The CONTRACTOR shall submit the Notice of Intent to Submit Claim, described above, within 20 days of the event, delay, omission, decision, or denial that gives rise to the Claim. However, no Claim for a change in Contract Time based on unusually severe weather may be made more than 30 days after the conclusion of the weather event claimed to be unusually severe.

The CONTRACTOR waives any Claims not submitted within these timeframes.

16.3. **Submittal of Claim**

The CONTRACTOR shall, within 15 days after it submits a Notice of Intent to Submit Claim, submit to the Chief Engineering Officer, Denver Water, 1600 W. 12th Avenue, Denver, Colorado 80204, with a copy to the Construction Project Manager, a complete and itemized written Claim in the form described below.

(The CONTRACTOR will have an extension of time to submit the Claim, if, and only if, within 15 days of submitting a Notice of Intent to Submit Claim, the CONTRACTOR submits, in writing, to the Chief Engineering Officer at the address above a Request for Extension to Submit Claim. This Request shall indicate the requested duration of and CONTRACTOR's good cause for the extension; good cause shall include only extraordinary circumstances and not ordinary business matters such as scheduling and staffing. The Chief Engineering Officer may, in his sole discretion, allow the requested extension but only in writing prior to the expiration of the time for submitting the Claim.)

The written Claim shall be clearly titled as such, signed, and dated. If the CONTRACTOR has previously submitted such a Claim, subsequent Claims shall be numbered sequentially: "Second Claim," etc. The Claim shall include, at a minimum, the information required above with regard to the Notice of Intent to Submit Claim and supporting detail sufficient for evaluation of the basis of and costs associated with the Claim. A Claim for an increase in Contract Price shall be based on actual costs rather than an estimate or opinion, shall be supported by invoices, time cards, and other business records commonly accepted in the industry, and shall comply with the requirements of this Agreement. The Claim shall include specific references to Contract Documents and any other documents supporting the Claim and include a summary of any legal and factual theories supporting the Claim. The Claim shall include copies of any relevant documents except that copies of Contract Documents are not required. A Claim for time extension shall be accompanied by a revision to the CLS described in Paragraph 2.6.1. that also shows the effects of the delay on the completion of critical path activities and shall be accompanied by a description of actions the CONTRACTOR has taken or proposes to take to minimize the effects of the delay. The Claim shall also identify any measures the CONTRACTOR believes the OWNER or the ENGINEER can take to minimize the Claim. Finally, the Claim shall include a notarized certificate, executed under penalties of perjury, that:

- the Claim is made in good faith;
- supporting data is accurate and complete to the best of the CONTRACTOR's knowledge and belief;
- the amount requested accurately reflects the total adjustment or relief that will be requested by the CONTRACTOR related to the described event; and
- the prices stated for material and equipment are the lowest reasonably available to the CONTRACTOR and include available discounts.

If the CONTRACTOR is an individual, the certification shall be executed by that individual. If the CONTRACTOR is not an individual, the certification shall be executed by an officer or general partner of the CONTRACTOR.

The CONTRACTOR shall furnish at no cost, upon request, additional information and data relevant to the Claim including the CONTRACTOR's books, correspondence, records, electronic files, and databases. Failure to submit requested information may be a basis for denial of the Claim.

Failure to submit the Claim, in writing, within the time period and in the manner described above shall constitute a waiver by the CONTRACTOR of any right, equitable or otherwise, to make such Claim. Neither the OWNER nor the ENGINEER is obligated to inform the CONTRACTOR of the CONTRACTOR's failure to comply with this process or to assist the CONTRACTOR in submitting a Claim.

The CONTRACTOR may amend a previously submitted Claim by submitting to the Chief Engineering Officer, with a copy to the Construction Project Manager, a complete and itemized written Amended Claim in the same form as the Claim described above. If the CONTRACTOR has previously submitted such an Amended Claim, subsequent Amended Claims shall be numbered sequentially: "Second Amended Claim," etc. However, an Amended Claim will not revive a Claim that has been waived as described in the preceding Paragraph.

The Claim shall be limited to 20 pages, five of which may be 11 inches by 17 inches. The text shall be at least 11-point font. The Claim shall clearly lay out the following information, in order:

- an executive summary of the Claim;
- a description of the changes driving the Claim;
- a summary of the Claim progression, including as applicable Submittals and responses to previous Change Order requests;
- concise exhibits illustrating key points (not volumes of materials), which will not count toward the page limit;
- a final summary proposing a Claim resolution.

16.4. **Resolution of Claim**

The Chief Engineering Officer will investigate, review, and evaluate the Claim and make a written, dated determination regarding the Claim within 60 days of the receipt of a Claim that meets the requirements stated above unless special circumstances exist or the Claim is unusually complex, in which case the Chief Engineering Officer will notify the CONTRACTOR, in writing, that an extended period of time is required and will state the reasons that an extended period of time is required and how much time is required. If the Chief Engineering Officer does not make a written determination within 60 days of receipt of the Claim or within 60 days of an extended period of time, the Claim is deemed to be denied. Any written decision will be transmitted to the CONTRACTOR immediately.

If the CONTRACTOR agrees with any determination or resolution by the Chief Engineering Officer, such determination or resolution will be processed as a Change Order or as an Amendment.

If the CONTRACTOR disagrees with the Chief Engineering Officer's written determination, the CONTRACTOR may, within 30 days of the date of such determination, initiate an appeal of said determination by sending to the Chief Engineering Officer a written Notice of Intent to Appeal to 1600 W. 12th Avenue, Denver, Colorado 80204 and a copy thereof to General Counsel, 1600 W. 12th Avenue, Denver, Colorado 80204. The Notice of Intent to Appeal shall contain a copy of the written determination being appealed, if any, and a short statement of the basis of the appeal. The conduct of the Appeal shall conform to the process described below.

16.5. **Administrative Hearing**

The Notice of Intent to Appeal and the conduct of the Appeal shall comply with the hearing and appeal procedures set forth in Chapter 17 of the Board's Operating Rules, available online: www.denverwater.org.

If a question arises concerning whether any issue or Claim raised in an administrative hearing is within the scope of the Contract's dispute resolution provisions, such question shall be decided by the hearing officer assigned to the administrative hearing.

All disputes of any nature whatsoever regarding the Contract, including without limitation Claims for additional compensation or extensions of time and disputes involving claimed breach of or default under the Contract, shall be resolved by the process described in this Article. The determination of the hearing officer on appeal shall be considered a final order and action of the Board and may be reviewed under Rule 106(a)(4) of the Colorado Rules of Civil Procedure only.

16.6. **General**

Should the OWNER or the CONTRACTOR suffer injury or damage to persons or property because of any error, omission, or act of the other party or of any of the other party's employees, agents, or others for whose acts the other party is legally liable, notice shall be made, in writing, to the other party within a reasonable time of the first observance of such injury or damage. The provisions of this Paragraph. shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitations or repose.

The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees, and obligations imposed upon the CONTRACTOR and the rights and remedies available to the OWNER and the ENGINEER thereunder, are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them that are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents and the provisions of this Paragraph shall be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply. Representations, warranties, and guarantees made in the Contract Documents will survive final payment and termination or completion of the Agreement. Notwithstanding the foregoing, the parties agree that no profits that the CONTRACTOR might realize from other work are within the scope of the parties' agreement and further agree that the CONTRACTOR waives any right to recover and shall not be compensated for any such lost profits or other consequential damages related to any breach by the OWNER hereunder.

ARTICLE 17--MISCELLANEOUS

Giving Notice:

17.1. Whenever any provision of the Contract Documents requires the giving of written notice, unless otherwise specified, it will be deemed to have been validly given if delivered in person to the individual, to a member of the firm, or to an officer of the corporation for whom it is intended; or, if delivered at, or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.2. **Computation of Time:**

17.2.1. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.2.2. A calendar day of 24 hours measured from midnight to the next midnight shall constitute a day.

17.2.3. References to days in the Contract Documents shall mean calendar days.

Equal Employment Opportunities:

17.3. The CONTRACTOR agrees not to discriminate against any employee, applicant for employment, or potential Subcontractor or Supplier based on race, color, religion, age, national origin, gender, sexual orientation, military status, marital status, or disability. The CONTRACTOR agrees to comply with applicable state and federal laws with regard to Equal Employment Opportunity.

Sanitary Conveniences:

17.4. The CONTRACTOR shall provide sanitary conveniences for use by persons employed on the Work. Sanitary conveniences shall be satisfactory to the ENGINEER and conform to the regulations of the public authority having jurisdiction over such matters. At the completion of the Work, sanitary conveniences shall be removed and the premises left in such condition that they will not be deemed unsanitary.

Gaseous Hazards and Confined Spaces:

17.5. The CONTRACTOR shall comply with Laws or Regulations related to entry into confined spaces and shall provide and properly maintain required safety equipment. In accordance with ARTICLE 6, the CONTRACTOR shall instruct its personnel in the proper use of the equipment and in the required procedures for access to confined spaces.

17.6. **Environmental Considerations:**

17.6.1. The OWNER strives to adhere to all applicable environmental laws, regulations, and policies. In addition, it utilizes an Environmental Management System to monitor and improve its environmental performance. In the performance of the Work, the CONTRACTOR shall comply with all applicable environmental laws, regulations, ordinances, specifications, reporting requirements, and any other relevant requirements. The CONTRACTOR shall restrict its construction activities to those methods that will prevent the entrance or accidental spillage of contaminants, debris, or other objectionable pollutants and wastes into storm sewers, streams, water courses, reservoirs, or underground water sources. Dewatering of trenches and structure foundations shall be done in a manner so as to prevent muddy water or eroded material from entering any drainage facility or waterway. Turbidity increases in a stream or other bodies of water that are caused by the construction activity shall be limited to the increases above the natural turbidities permitted under the state water quality standards for that stream or body of water or by specific authorization from the appropriate governmental agency.

17.6.2. The CONTRACTOR shall conduct its construction activity in a manner that will maintain the noise level below the decibel limit set by the local governing authority. The CONTRACTOR shall comply with applicable federal, state, and local laws, orders, or regulations concerning the prevention, control, and abatement of excessive noise.

17.6.3. The CONTRACTOR shall comply with applicable federal, state, and local laws, orders, or regulations concerning the prevention and abatement of air pollution. During construction, the CONTRACTOR shall utilize such practicable methods and devices that are available to control, prevent, and otherwise minimize the atmospheric emission of air contaminants.

The burning of materials resulting from the clearing of trees and brush, construction materials, and other rubbish will not be permitted. Equipment and vehicles that show an excessive emission of exhaust gases due to poor engine adjustments or inefficient operating conditions shall not be used until corrective repairs or adjustments are made.

17.6.4. During the performance of the Work required by these Specifications or of any operations appurtenant thereunto, whether on rights-of-way provided by the OWNER or elsewhere, the CONTRACTOR shall furnish the labor, equipment, materials, and means required and shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance and to prevent dust that has originated from its operations from damaging dwellings or causing a nuisance to persons. The CONTRACTOR shall be liable for any damage resulting from dust originating from its operations under these Specifications in the streets, the OWNER's rights-of-way, or elsewhere. The cost of sprinkling or of other methods of reducing the formation of dust shall be included in the price Bid in the schedule for other items of Work.

17.7. **Water for Construction Purposes:**

17.7.1. The OWNER will furnish water for construction purposes free of charge to the CONTRACTOR at hydrants located within the City and County of Denver or within total service and read and bill water districts. Hydrants located in Master Meter Water Districts are outside of the control of the OWNER; therefore, the CONTRACTOR shall make arrangements with the water districts in question and pay charges required by the districts. A list of hydrants that would be accessible to the CONTRACTOR but that are located in a Master Meter area may be obtained from the ENGINEER.

17.7.2. The CONTRACTOR shall be required to obtain from the OWNER a hydrant permit listing each hydrant used and a water tank wagon permit for each tank wagon used. The permits are free of charge and shall be in the possession of the CONTRACTOR at the hydrant during the time the hydrant is being used. The permits will be valid for a period of one year from the time of issuance or until Contract completion, whichever occurs first. Any damage done to the hydrant by the CONTRACTOR will be repaired by the OWNER with the actual cost of such repairs billed to the CONTRACTOR.

In accordance with the Board's Engineering Standards and Operating Rules, the CONTRACTOR shall provide and use the required, approved, and properly supported fire hydrant meter, backflow prevention device, and gate valve. The CONTRACTOR is subject to the OWNER's hydrant use rules, regulations, and fines for violation.

17.7.3. The OWNER will furnish to the CONTRACTOR free of charge water required for testing and chlorine required for sterilization. The OWNER may perform labor necessary to fill the facility requiring testing with water and will insert the chlorine into the facility for final sterilization; however, the CONTRACTOR shall perform other labor.

17.8. **Electrical Power for Construction Purposes:**

17.8.1. The CONTRACTOR shall make necessary arrangements and shall provide electric power required for its construction purposes. This shall include providing necessary transmission lines, distribution circuits, transformers, and other electrical equipment required for distributing the power to the place or places of use by the CONTRACTOR.

17.8.2. At the termination of the Contract under these Specifications, the CONTRACTOR shall dismantle and remove distribution lines and appurtenant equipment serving its installations or those of its Subcontractors that are not part of the permanent power installation.

17.8.3. In the event the CONTRACTOR is working on properties owned by the OWNER, the CONTRACTOR will be allowed to take power from the nearest usable source where available. The CONTRACTOR is responsible for obtaining any supplemental power or equipment upgrades necessary to perform the Work. The OWNER will not charge the CONTRACTOR for the power, but the CONTRACTOR shall be responsible for the installation and removal of distribution lines and appurtenant equipment necessary for supplying the power to its place of use and for any measures necessary to protect the OWNER's facilities from faults.

ARTICLE 18--CONSTRUCTION ACCOUNTING AND AUDITING

Project Auditing: For CMAR and CM/GC Contracts

18.1. Provisions refer to various sections of the General Conditions as noted. The OWNER reserves the right to audit wages, salaries, associated employee benefits, equipment rated, and reimbursable expenses for Work where the price is cost of the Work plus a fixed Project Fee, for any Work performed under time, materials, and fixed Project Fee, including components of both direct and indirect costs, and when Contract contains unit pricing of cost of Work in addition to a Lump Sum price.

18.2. The OWNER will not audit lump sum fixed price Self Perform Work which shall include associated Direct and Indirect Work. This shall not be interpreted as restricting the information available to the OWNER under any other provisions of the General Conditions including, but not limited to, ARTICLE 11.

18.3. The OWNER will have access to records and the right to audit as follows:

1) The CONTRACTOR shall make available to the OWNER, on 48 hours' notice, either on-site or at the CONTRACTOR's local Metropolitan Denver office, from time to time, which shall include, but not be limited to, project related books, records, accounting methods, work papers, computer files, Supplier invoices, Supplier rebates or refunds, purchase orders, Subcontractor billings, subcontracts, consultant billings, payroll records,

timekeeping records, travel vouchers, costs estimates, sources of cost estimate data, and other records that relate to costs estimated, incurred, charged, or allocated directly to this Project.

2) The CONTRACTOR shall make available accounting and project management personnel with knowledge of the records listed above, subject to reasonable limitations due to work and travel demands. Such personnel shall be made available free of charge for the duration of the Project and at a negotiated rate following close-out of the Project.

3) The CONTRACTOR shall retain records, as listed above, for 5 years after the date of final payment for this Project, and shall make such records available to the OWNER during such period.

4) Payment to the CONTRACTOR will be equal to actual amounts paid to Subcontractors, approved amounts for Self Perform Work, and approved general conditions limited to the agreed maximum amount and the overhead and profit applicable to these items by Contract. Payment will be made for actual amounts paid for bonds, insurance, and permits. The total of payments made shall not exceed the Total Project Cost with the Total Project Cost adjusted by approved Change Order amounts.

5) No cost, hours worked, or expenditure may be charged more than once to the Project. Costs shall be charged to the cost element of the Project where incurred. Labor hours charged shall not exceed hours actually worked.

6) Any costs billed to the OWNER by the CONTRACTOR which are not allowed by the Contract Documents, as determined by audit by the OWNER, will be deducted from payments due the CONTRACTOR, or the CONTRACTOR agrees to refund to the OWNER costs charged to the OWNER, which are found through the OWNER's audit to be not in conformance with the provisions of this Contract.

7) The OWNER and its representatives will enter into an appropriate confidentiality agreement pertaining to financial information provided as part of the accounting and auditing process if so requested by the CONTRACTOR.

18.4. Make available to the OWNER, on 48 hours' notice, either on-site or at the CONTRACTOR's local Metropolitan Denver office, documents related to personnel employed on the Project as reasonably necessary for the OWNER to determine whether the CONTRACTOR has complied with its personnel screening and non-disclosure obligations.

Project Accounting:

18.5 The CONTRACTOR's accounting system and processes shall meet the following requirements:

1) The CONTRACTOR shall demonstrate to the OWNER and use a cost accounting system sufficient to:

   a) Accurately record and charge actual direct costs which benefit this Project, for general conditions, bonds, insurance, permits, and Change Orders.

   b) Assure that costs charged to this Project relate ONLY to this Project.

2) The CONTRACTOR shall demonstrate to the OWNER and use a cost control system sufficient to provide reasonable assurance that costs are not incurred and charged by the CONTRACTOR in excess of those necessary for the timely and effective performance of the Contract.

3) The CONTRACTOR shall remedy deficiencies in the CONTRACTOR's cost accounting and cost control systems as deemed necessary by the OWNER to achieve a standard of cost accounting and cost control generally recognized as good practice in the construction industry.

INTENTIONALLY BLANK

SECTION 01 14 13
ACCESS TO SECURE SITES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for access to secure sites.

B. Related Sections:

1. SECTION 01 50 00 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT

1.2 DEFINITIONS

A. Badged: CONTRACTOR personnel at the Work site on a consistent and daily basis and are issued a DW Contractor Photo ID or Access Control Badge by DW Security.

B. CONTRACTOR personnel: CONTRACTOR employees, Subcontractors, Suppliers, Manufacturers, and other personnel designated by the CONTRACTOR performing the Work.

C. Secure Site: Treatment Plants, Pump Stations, Dams, Reservoirs, Westside Complex, and other areas designated by the ENGINEER.

D. Un-Badged: CONTRACTOR personnel and other persons not on the Work site on a daily or scheduled basis and are issued a daily visitor's badge.

1.3 COORDINATION

A. Prior to allowing access by CONTRACTOR personnel to restricted job sites, the CONTRACTOR needs to be approved and listed on the Security Prequalified Contractor List. Refer to DW CONTRACTOR personnel screening requirements and forms: https://www.denverwater.org/contractors/bid-and-contract-opportunities/capital-project-prequalification. and comply with the requirements applicable to the Security Prequalified Contractor List and the signed Affidavits.

B. Escort:

1. The ENGINEER will identify the level of escort required for the Work location. Various levels of escort may be required for access to specific locations to complete the Work. Escorts will be provided by the OWNER. The CONTRACTOR shall anticipate short delays to access Highly Restricted Work locations for coordinating with the OWNER's escorts. The function of the escort will be to observe specific construction activities and coordinate emergencies or other critical communication with the OWNER.
2. Site escort levels:
   a. Highly Restricted: Escort is 100% on-site where Work is being performed. Access to certain areas at the Work site may require the ENGINEER to observe the Work 100% of the time.
   b. Restricted: Escort is 50% to 100% on-site where Work is being performed.
   c. Internal – Less Restricted: Escort is intermittently on-site where Work is being performed.

C. Storage and Staging Area Requirements: As specified in SECTION 01 50 00 and SECTION 01 60 00.

1.4 SEQUENCING AND SCHEDULING

A. Comply with area and building security policies of the OWNER.

B. Secure sites are considered restricted areas and are subject to additional site-specific security procedures:

1. Supply the names of CONTRACTOR personnel before the start of construction or before Work begins by completing the SAL. The ENGINEER will supply the SAL in XLSX format for the CONTRACTOR'S use. Maintain a current SAL at all times such that new personnel can gain access to the site. Specific on-site training may be required for certain locations. A printed SAL listing CONTRACTOR personnel authorized access to the Work site will be maintained at the Security Access Point at the entrance of the facility. The ENGINEER will review the log. A visitors badge will be issued to all CONTRACTOR personnel at the time of entry and shall be returned upon departure.
2. Requirements for SAL access are summarized as follows and also needs to comply with the applicable requirements detailed in the Security Prequalified Contractor List:
   a. The person has been subject to a Colorado Bureau of Investigation or other US State or Federal equivalent background check within the past 12 months.
   b. The person has undertaken and completed any necessary site-specific training as deemed necessary by the OWNER.
   c. A record of the background check and the site-specific training is maintained for CONTRACTOR personnel and provided to the ENGINEER upon request.
3. The names of CONTRACTOR personnel making planned pickup or delivery visits shall be entered on a separate SDL 12 hours prior to the pickup or delivery. The ENGINEER will supply the SDL in XLSX format for the CONTRACTOR's use. Maintain a current SDL at all times and send updates to the OWNER or the ENGINEER to gain access for deliveries to the site. CONTRACTOR personnel listed on the SDL that make routine short-term pickup or delivery visits to the site shall sign in and be issued a visitor badge when they present an approved form of identification matching the SDL. They will be allowed unescorted access along predetermined routes to a delivery point. The visitor's badge shall be returned to the point of entry upon departure. The SDL permits entry on a one-time daily basis and does not carry over to following days. For recurring site access permissions to the secure site, see SAL requirements.
4. Badged personnel and un-badged/badged personnel shall present one of the following approved forms of identification:
   a. Current US state issued driver's license.
   b. State issued ID.
   c. US military ID.
   d. Current passport.

e. US alien registration card with photo.
f. US visa or work documents.

5. Provide a Site Access Administrator with authority to manage on-site access issues.
6. CONTRACTOR personnel entering the site are required to check in at the security access point at the property entrance and provide an approved form of identification.
7. There may be occasions when CONTRACTOR personnel shall be required to provide an approved form of identification in exchange for a visitor's badge to gain authorized site access.
8. Notify the ENGINEER in writing, within 1 day when CONTRACTOR personnel have been reassigned or employment has been terminated; update the SAL. Return the badge to the ENGINEER upon reassignment or termination of employment within 7 days.
9. Immediately notify the ENGINEER in writing of any lost or stolen photo ID or access control badges.
10. Display badges on the upper half of the body with the picture visible.
11. Media representatives are not allowed on sites without prior written approval by the ENGINEER. Site visits shall be coordinated with the ENGINEER.
12. In locations where the CONTRACTOR is responsible for the construction area, the specific badging procedures to be used will be agreed upon by the ENGINEER in coordination with the DW Manager of Safety and Security and the CONTRACTOR and established at the Pre-Construction Meeting. Provide samples of such identification or badges at the Pre-Construction Meeting for approval.
13. Access privileges, both physical and informational, shall terminate on the Final Completion date. Return issued badges to the ENGINEER within 7 days of the Final Completion date. For each unreturned badge, the CONTRACTOR may be charged $250.

1.5 SUBMITTALS

A. Supplements listed in this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 SUPPLEMENTS

A. Supplement A – SAL
B. Supplement B – SDL

END OF SECTION

SUPPLEMENT A
SAL

Location:

Project:

Contract:

Date:

SECTION 01 14 13 ACCESS TO SECURE SITES – includes general information and execution procedures for access to secure sites. It requires CONTRACTOR personnel screening, sequencing, scheduling, and the issuance of identification badges for CONTRACTOR personnel working at this Work site. In submitting this SAL to DW, I certify the following log is accurate and required records are on file with the CONTRACTOR.

Company Name:

SAL Administrator's Name and Phone Number:

Random audits may occur throughout the course of the Project. Records of on-site personnel will be reviewed for compliance. Non-compliance noted during the audit may result in the suspension of the CONTRACTOR from bidding DW projects and/or other consequences.

CONTRACTOR Personnel

Last Name	First Name	Company	DW Site Supervisor Access Permitted (Yes or No)	Required Training (Yes or No)	Date

Administer SAL procedure in accordance with the following:

List all personnel on the SAL that will be performing Work on-site.

Submit an updated SAL 2 days in advance for additional personnel requiring access.

No one will be permitted on-site unless they are on the SAL and have complied with the associated requirements.

The ENGINEER will send the updated SAL to the DW Site Supervisor who determines site access approval.

The DW Site Supervisor will forward the updated SAL to the security access point and send it back to the CONTRACTOR.

INTENTIONALLY BLANK

SUPPLEMENT B
SDL – Deliveries and 1 Day Access only (needs escort)

Location:					
Project:					
Contract:					
Date:					

01 14 13 – ACCESS TO SECURE SITES – includes general information and execution procedures for access to secure sites. In submitting the SDL to DW, I certify the following log is accurate and access is only permitted for deliveries or 1 day access that will require a DW escort.

Company Name:

SDL Administrator's Name and Phone Number:

Random audits may occur throughout the course of the Project. Records of all on-site personnel will be reviewed for compliance. Non-compliance noted during the audit may result in the suspension of the Contractor from bidding DW projects and/or other consequences.

Deliveries/1 Day Access

Last Name	First Name	Company	DW Site Supervisor Access Permitted? (Yes or No)	Date

Administer SDL procedure in accordance with the following:

List all deliveries and visitors (1 day access) on the SDL that will be performing Work on-site.

Submit an updated SDL 1 day in advance for deliveries and visitors requiring access.

No one will be permitted on-site unless they are on the SDL and have complied with the associated requirements.

The ENGINEER will send the updated SDL to the DW Site Supervisor who determines site access approval.

The DW Site Supervisor shall forward the updated SDL to the security access point.

INTENTIONALLY BLANK

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for payment procedures.

B. Related Sections:

1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
2. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA

1.2 PRICE AND PAYMENT PROCEDURES

A. Payment:

1. Progress payments will be made in accordance with the Agreement Form and ARTICLE 14 of the General Conditions.
2. Payment for Lump Sum Work covers the Work required by the Contract Documents.
3. The progress payment values for preliminary and final manuals shall be as specified in SECTION 01 32 16 (.01 or .02).

B. Nonpayment for Rejected or Unused Products:

1. Payment will not be made for:
   a. Loading, hauling, and disposing of rejected material.
   b. Quantities of material wasted or disposed of in a manner not called for under the Contract Documents.
   c. Rejected loads of material, including material rejected after it has been placed for failure to conform to provisions of the Contract Documents.
   d. Material not unloaded from the transporting vehicle.
   e. Defective Work not accepted by the OWNER.
   f. Material remaining on hand after completion of the Work.

C. Partial Payment for Stored Materials and Equipment:

1. Partial payment will be made for materials and equipment delivered or stored only if materials are accepted, General Condition's requirements are met, and the preliminary O&M manuals have been approved.
2. Final payment will be made only for materials incorporated in the Work; remaining materials, for which partial payments have been made, shall revert to the CONTRACTOR and partial payments made for those items will be deducted from the final payment.
3. Payment requirements associated with equipment and systems and preliminary O&M manual submittal as specified in SECTION 01 78 23.

1.3 DEFINITIONS

A. Construction Schedule of Values: Allocates values for the various parts of the Work (activities or groups of activities/categories) used as the basis for submitting and reviewing progress payments.

1.4 SUBMITTALS

A. Schedule of Estimated Progress Payments:

1. Submit with the CLS.
2. Submit adjustments with Applications for Payment.

B. Construction Schedule of Values:

1. Prepare the construction schedule of values for Work under the Agreement in accordance with ARTICLE 2 and ARTICLE 14 of the General Conditions, and as specified in SECTION 01 32 16 (.01 or .02).
2. The total of the construction schedule of values shall equal the Contract Price.

C. Application for Payment:

1. Submit monthly by using the approved Application for Payment Form.
2. Submit on the date stated in ARTICLE 14 of the General Conditions and include the accepted construction schedule of values.
3. Submit an updated CLS in accordance with the General Conditions with each monthly Application for Payment.
4. Preparation:
   a. List each Change Order and Written Amendment executed prior to the date of submission as a separate line item.
   b. Execute certification by the authorized officer of the CONTRACTOR.

D. Final Application for Payment: Submit in accordance with Final Payment Release.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for project management and coordination.

B. Related Sections:

1. SECTION 01 91 00 (.01 or .02) – COMMISSIONING
2. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS
3. SECTION 40 50 00 – INSTRUMENTATION AND CONTROL SYSTEMS

1.2 COORDINATION

A. Separate Contracts:

1. Refer to ARTICLE 7 of the General Conditions for the coordination of Work under separate contract(s).
2. Coordinate the CONTRACTOR's Work with separate Contractors.
3. Coordinate with the OWNER and the ENGINEER to avoid delays to separate contracts.

B. Coordinate with the OWNER's normal activities on or near the site to:

1. Maintain roads so that they are fully operational during the Work.
2. Allow access by the OWNER's personnel to the Work area as required to maintain operations.

C. OWNER Occupancy:

1. The OWNER's personnel will:
   a. Occupy the premises during the Work for the conduct of their normal operations.
   b. Occupy existing buildings and use existing streets and parking areas during the Work.
2. Cooperate with the OWNER's personnel to minimize conflict and to coordinate the usage of facilities.

D. City and County of Denver (City) Street Cut and Occupancy Permits Requirements:

1. Applicable to projects within the City.
2. Coordinate directly with the City Representative: Michael Holm, Department of Transportation and Infrastructure, Engineer and Architect Manager, 2000 W. 3rd Avenue, Room 231, Denver, CO 80223-1027, 303-446-3639.
3. Apply for City permits via the City's online permitting and licensing center.
4. Obtain a Street Cut Permit as required by the City for Work. City Street Cut Fees will not be assessed to related Work.
5. Obtain a City Street Occupancy Permit which covers road closures, traffic control, parking, and related issues associated with the Work.
   a. Occupancy Permit Fees will not be assessed related to the Work for impacts to traffic lanes, center lanes, alleys, sidewalks, and meter bagging if Work is completed within the permitted duration.
   b. Obtain a second Occupancy Permit if Work activities extend beyond the original permitted duration. The City will review the Work status and issue the CONTRACTOR a second Permit at a rate up to twice the prevailing Permit Fees at CONTRACTOR's expense.
6. Fees for City parking meter permits shall be waived.
7. Work hours are project specific and the City may require weekend construction or nights to limit lane closures during rush hours or business hours.
8. Special events may limit working hours and allowable working days.
9. Work within the Central Business District (Downtown), Cherry Creek retail areas, and the Central Park/Forest City retail areas, including the Shops at Northfield, may be subject to the City's Holiday Construction Moratorium.
10. If Work is downtown, attend the City's bi-weekly downtown coordination meeting.

E. Outages of DW Conduit, Transmission, and Distribution Piping:

1. Notify the ENGINEER in writing, 1 week in advance of when a water conduit, transmission, or distribution main needs to be taken out of service. Provide an estimate for the shutdown time required.
2. Where needed, the OWNER will dewater existing waterlines greater than 24-inches in diameter to invert elevation.
3. The OWNER does not guarantee the shut-out will be watertight and any subsequent dewatering shall be the CONTRACTOR's responsibility.

1.3 PRE-INSTALLATION MEETINGS

A. Administer a pre-installation meeting prior to the start of major portions of the Work.

1. The major portions of the Work that will require a pre-installation meeting are at the ENGINEER's discretion. Examples of major portions of Work that may require a pre-installation meeting include, but are not limited to, pipe installation, concrete installation, masonry work, and electrical work.
2. A list of pre-installation meetings shall be included in the QC plan submitted by the CONTRACTOR.
3. A pre-installation meeting may also be listed as a requirement in an individual specification section.
4. Notify the ENGINEER of a pre-installation meeting 10 days in advance of the meeting date and not less than 10 days in advance of the start of the Work. Prepare an agenda, conduct the meeting, and distribute meeting minutes and an attendance log.
5. For each pre-installation meeting, review and discuss the following suggested subjects:
   a. Safety.
   b. Scheduling and sequencing.
   c. Contract and Shop Drawings.
   d. Specifications and industry standards.
   e. Quality control and quality assurance.
   f. Submittals.
   g. Constructability and logistics.

h. Coordination with other entities and trades (if applicable).
i. Trade specific issues.
j. Startup and commissioning (if applicable).

6. Minimum attendance:
   a. CONTRACTOR (Project Manager, Project Engineer, Superintendent, and Foreman).
   b. Suppliers.
   c. Subcontractors.
   d. ENGINEER.
   e. OWNER.
   f. Others affecting or affected by the Work.
7. A log of resolutions, decisions, and clarifications shall be kept during the meeting and distributed with the meeting minutes and the attendance sheet.

B. Other Meetings:
1. General:
   a. Make arrangements for meetings throughout the progress of Work.
   b. Prepare a meeting agenda for meetings (with the exception of the Pre-Construction Meeting) with input from the OWNER's consultant and the ENGINEER. Distribute the agenda with notice of each meeting.
   c. Preside at the meetings, record the minutes of proceedings and decisions, and reproduce and distribute copies of the minutes to participants and parties affected by meeting decisions within 5 days after each meeting.
2. Pre-Construction Meeting:
   a. The ENGINEER will prepare the agenda.
   b. Review and discuss the following subjects at a minimum:
      1) Required schedules.
      2) Groundwater control.
      3) Erosion/sediment control and wetlands protection plans.
      4) Status of bonds and insurance.
      5) Sequencing of critical path Work items.
      6) Work changes and clarification procedures.
      7) Use of site, access, office and storage areas, security, and temporary facilities.
      8) Major product deliveries and priorities.
      9) CONTRACTOR's safety plan.
      10) Progress payment procedures.
   c. Minimum attendance:
      1) The OWNER's Representatives, including the ENGINEER.
      2) The CONTRACTOR's office representative.
      3) The CONTRACTOR's Resident Superintendent.
      4) The CONTRACTOR's Quality Control Representative.
      5) The CONTRACTOR's Safety Representative.
      6) Subcontractors' and Suppliers' Representatives as the CONTRACTOR or the ENGINEER deem appropriate.
      7) The OWNER's consultant.
      8) Others as appropriate to the agenda.
3. Progress meetings:
   a. Schedule weekly progress meetings at the site to review Work progress, CLS, Shop Drawing and Sample submissions schedule, Applications for Payment, Contract modifications, and other matters requiring discussion and resolution.
   b. Minimum attendance:
      1) The OWNER's representatives including the ENGINEER as appropriate to the agenda.
      2) The CONTRACTOR, Subcontractors, and Suppliers as appropriate to the agenda.
      3) The OWNER's Consultant, if requested by the ENGINEER.
      4) Others as appropriate to the agenda.
4. Quality control and coordination meetings:
   a. Scheduled by the ENGINEER to review test reports, inspection reports, and other matters relating to the quality control of the Work and the work of separate CONTRACTORs.
   b. Minimum attendance:
      1) The OWNER's representatives including the ENGINEER as appropriate to the agenda.
      2) The CONTRACTOR, Subcontractors, and Suppliers as appropriate to the agenda.
      3) The OWNER's Consultant, if requested by the ENGINEER.
      4) Others as appropriate to the agenda.
5. Facility commissioning and startup meetings:
   a. Schedule and attend facility commissioning and startup meetings prior to submitting a facility startup plan as specified in SECTION 01 91 00.
   b. Minimum agenda:
      1) Preliminary discussions regarding the facility commissioning and startup plan, including testing procedures and testing documentation forms, individual system or equipment startup and testing plans,

and testing procedures and testing documentation forms to integrate the individual system startup plans into the facility startup plan.

2) The facility startup and commissioning plan and schedule shall, at a minimum, include:
   a) Submittal and ENGINEER review period of preliminary O&M manuals.
   b) Submittal and ENGINEER review period of final O&M manuals.
   c) Commissioning of electrical systems prior to energizing electrical equipment.
   d) Manufacturer's certification of proper operation.
   e) Factory demonstration tests.
   f) Phase I ORTs.
   g) Phase II ORTs.
   h) PATs.
   i) I&C acceptance test.
   j) Facility startup evaluation tests.
   k) Training sessions.
   l) Other requirements as specified in SECTION 01 91 00, SECTION 26 08 00, and SECTION 40 50 00.
   m) Other tests and activities as requested by the ENGINEER.
   n) Content of facility commissioning and startup plan and detailed review of the individual facility commissioning and startup procedures.
   o) Coordination between the CONTRACTOR, the ENGINEER, the OWNER and the other Stakeholders.
   p) Potential problems associated with commissioning and startup.
3) Minimum attendance:
   a) The OWNER's and ENGINEER's representatives, including the Design Project Engineer, Electrical Engineer, CPM, Construction Project Inspector, Construction I&C Inspector, and the OWNER's Operating and Maintenance personnel, as appropriate.
   b) The OWNER's Consultant, if requested by the ENGINEER.
   c) The CONTRACTOR's Commissioning Manager.
   d) CONTRACTOR's Project Manager.
   e) CONTRACTOR's Resident Superintendent or Foreman.
   f) CONTRACTOR's Subcontractors participating in startup activities including electrical, controls integrator, mechanical and HVAC Subcontractors, as appropriate.
   g) Equipment Manufacturers and vendors as requested by the ENGINEER.
   h) Others as appropriate to the agenda.
4) Meeting frequency: Monthly in the first half of the Project or when requested by the ENGINEER.
   a) During the commissioning and startup periods, meeting frequency shall be increased and shall include:
      (1) Weekly or daily meetings, as appropriate during initial commissioning efforts.
         (a) Discuss schedule.
         (b) Discuss daily commissioning activities.
         (c) Discuss issues from previous day's activities including problems and resolutions.
5) Location: At the site or the ENGINEER's office, as approved by the ENGINEER.
6) Meeting minutes shall be prepared by the CONTRACTOR and approved by the ENGINEER.
7) Updated facility startup and commissioning schedules shall be provided at each meeting unless otherwise approved by the ENGINEER.

6. Refocus meetings:
   a. The ENGINEER may require a refocus meeting, as called for in the CPPM, as necessary for successful completion of the Work.
      1) Refocus meetings are held to identify the need to change or verify Work direction and clarify expectations for delivery of:
         a) A realistic and comprehensive CLS.
         b) O&M manuals (electronic and hardcopy).
         c) Record Drawings.
         d) Any outstanding Work issues that need to be addressed for project completion and contract closeout.
      2) Attendees shall include:
         a) OWNER.
         b) ENGINEER and Subconsultants.
         c) CONTRACTOR and Subcontractors.
         d) Appropriate Suppliers.

1.4 SEQUENCING AND SCHEDULING

A. Milestones: Complete the construction of Milestones by the dates shown in the Contract Documents. These activities are critical to the overall completion of Work and are subject to liquidated damages as provided in the Agreement Form.

1.5 SITE CONDITIONS

A. Adjacent Facilities and Properties:
   1. Examination:
      a. After the Effective Date of the Agreement and before Work at the site is started, meet at the site with the ENGINEER and affected property and utility entities. Make a detailed examination of existing conditions

including existing buildings, structures, and other improvements in the vicinity of the Work that may be damaged by construction operations.
    b. Periodically re-examine, jointly with the ENGINEER and affected property utility entities, for cracks in structures, settlement, leakage, and similar conditions.
2. Documentation:
    a. Submit two copies of photographs, videotapes, and other records documenting examination for the ENGINEER's approval. The ENGINEER will review, sign, and return one record copy to the CONTRACTOR to be kept on file in the CONTRACTOR's field office as site records. Provide approved record copies to utility entities, if requested.
    b. Observations and photographs are intended for use as indisputable evidence in determining whether and to what extent damage occurred as result of the CONTRACTOR's operations, and are for the protection of adjacent property, the CONTRACTOR, and the OWNER.

B. Existing Utilities:
1. Coordinate proposed Work with the ENGINEER, the OWNER, and other affected utilities before beginning Work that could interfere with the operations of others.
2. Notify applicable utilities prior to starting Work, if damage occurs, or if conflicts or emergencies arise during Work.
3. Existing Utility Entities as specified in the Contract Documents.
4. Provide bypass facilities and temporary connections acceptable to the ENGINEER that are required to maintain the existing utilities' operations.
5. Do not plug lines, operate valves, or take other actions that would affect the operation of existing systems, except as specifically required by the Contract Documents.
6. Connections to existing facilities:
    a. Obtain permission from the OWNER or utility owner prior to making connections.
    b. Make necessary connections to existing facilities including structures and utilities.
    c. Plan the connections to existing facilities that are in service in advance; provide required equipment, materials, and labor at the time of undertaking the connections.
    d. The OWNER or utility owner will supervise the operation of valves or other appurtenances on existing utilities.
    e. Protect facilities against deleterious substances and damage.

C. Exercise reasonable care to verify the locations of existing subsurface structures and underground facilities.

D. Check immediate and adjacent areas that are subject to excavation by visual examination, and by electronic metal and pipe detection equipment if necessary, for indications of subsurface structures and underground facilities.

E. Make exploratory excavations where existing underground facilities or structures may potentially conflict with proposed underground facilities or structures. Conduct exploratory excavations in the presence of the ENGINEER, or utility owner sufficiently ahead of construction to avoid delays to Work.

F. Existing Facilities:
1. Relocation of existing facilities:
    a. Anticipate minor relocations of existing facilities during the Work.
    b. Provide the complete relocation of existing structures and underground facilities as specified in the Contract, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct banks, and other necessary items.
    c. Use new materials for relocated facilities; match the materials of the existing facility.
    d. Perform relocations to minimize the downtime of existing facilities.
    e. Install new portions of existing facilities in the relocated position prior to the removal of existing facilities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for construction progress documentation.

1.2 QUALITY ASSURANCE

A. Record Documents:

1. Provide a qualified and experienced person whose duty and responsibility is to maintain Record Documents.
2. Accuracy of records:
   a. Coordinate changes within Record Documents; make legible and accurate entries on each page of the Specification Sections and each sheet of the Drawings and other documents where such entry is required to show the change.
   b. Document factual information regarding aspects of the Work, both concealed and visible, to enable the future modification of the Work to proceed without extensive site measurement, investigation, and examination.
3. Make entries within 1 day after the receipt of information that a change in the Work has occurred.
4. Request the ENGINEER's review and approval of the current status of Record Documents prior to submitting each request for progress payment.
5. Failure to properly maintain, update, and submit Record Documents may result in a deferral by the ENGINEER to recommend approval of the whole, or any part, of the CONTRACTOR's application for progress payment, either partial or final.

1.3 SITE CONDITIONS

A. Construction Photographs:

1. Take photographs at major phases of construction that meet the following requirements:
   a. Take with a high-resolution digital camera (five megapixels, or higher).
   b. Neatly label the photograph with the date, the name of the photographer, and the component the photographs are depicting.
   c. Submit the photograph electronically in JPEG format on compact disc with each progress payment.

B. Periodic Site Observations:

1. The ENGINEER will make site observations in accordance with the General Conditions.
2. The OWNER's personnel on official business may visit the site to monitor and audit progress.
3. Periodic site visitation will be arranged by the OWNER in accordance with the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. Maintenance of Record Documents:

1. General:
   a. Promptly following the commencement of Contract Time, secure from the ENGINEER, at no cost to the CONTRACTOR, one complete set of Contract Documents.
   b. Label or stamp each Record Document with the title, "Record Documents," in neat, large, printed letters.
   c. Record information concurrently with the construction progress.
   d. Do not cover or conceal Work until the required information is recorded.
2. Preservation:
   a. Maintain documents in good order in a clean, dry, and legible condition.
   b. Do not use Record Documents for construction purposes.
   c. Make documents available at all times for observation by the ENGINEER.
3. Entries on Drawings:
   a. Date entries.
   b. Use an erasable, colored pencil; clearly describe a change by graphic line and note, as required.
   c. Color coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
   d. Call attention to an entry by inserting a drawn cloud around each area affected.
   e. Legibly mark to record actual changes made during construction including, but not limited to:
      1) The depths of various elements of the foundation in relation to finished first floor data if not shown on the Drawings or where depth differs from that shown on the Drawings.
      2) The horizontal and vertical locations of existing and new underground facilities and appurtenances and other underground structures, equipment, or Work. A reference to at least two measurements to permanent surface improvements. The Manufacturer, type, serial numbers, model numbers, and size of new valves and miscellaneous piping fittings.
      3) The location of internal utilities and appurtenances concealed in construction that are referenced to visible and accessible features of the structure.
      4) The location of existing facilities, piping, equipment, and items critical to interface between existing physical conditions or construction and new construction.
      5) Changes made by Field Orders, Work Change Directive, Change Order, Written Amendment, and the ENGINEER's written interpretation and clarification using consistent symbols for each and showing the appropriate document tracking number.

6) Underground and embedded electrical, instrumentation, control conduits, and ductbank runs dimensioned from established building lines.
7) Changes or departures from electrical, instrumentation, and control.

f. Dimensions on schematic layouts: Show on Record Documents, by dimension, the centerline of each run of items such as those described in the previous subparagraph.
1) Clearly identify the item by an accurate note (e.g., CI drain, galv. water).
2) Show, by symbol or note, the vertical location of the item (e.g., under slab, in ceiling plenum, exposed).
3) Make identifications descriptive so that they may be related to the Specifications.

g. Specifications: Legibly mark and record for each product description the actual product installed if it differs from that specified, including: Manufacturer, trade name, and catalog model number of each product and item of equipment actually installed.

END OF SECTION

SECTION 01 32 16.01
COST LOADED SCHEDULE (FOR COMPLEX PROJECTS)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for cost loaded schedules.

B. Related Sections:

1. SECTION 01 29 00 – PAYMENT PROCEDURES

1.2 PRICE AND PAYMENT PROCEDURES

A. Payment Deductions: A permanent line-item deduction, at the pro-rata rate of $2,000 per month, will be deducted from the Contract Price if, in the judgment of the CPM, the CONTRACTOR is deemed to be the cause for the delay in submitting the CLS or subsequent monthly updates as discussed in monthly progress meetings and reports. The CONTRACTOR will be notified within 1 week of said delinquency that the permanent deduction is being assessed against the Contract.

1.3 DEFINITIONS

A. 3-Week-Look-Ahead-Schedule: A schedule derived from the CLS that includes the week in which the schedule is presented plus the next two successive weeks.

B. Adverse Weather: Atmospheric conditions at a definite time and place that are unfavorable to construction activities.

C. Cash Flow: Synonymous with estimated progress payments.

D. CLS: A detailed schedule of individual activities required to complete the Work and their associated cost that the CONTRACTOR anticipates requesting partial payment for as the Work is progressively completed. References to schedule or construction schedule mean CLS; activities and total associated costs in the CLS shall be equal to the Contract Price.

E. Construction Schedule of Values: Allocates values for the various parts of the Work (activities or groups of activities/categories) used as the basis for submitting and reviewing progress payments.

F. Critical Path: A series of sequentially linked activities in a Project schedule that will take the longest total amount of time to complete. At any point in time, the critical path will be the path with the least amount of total float.

G. Early Finish: The earliest a schedule activity is expected to finish, based on its relationship to other activities in the Work.

H. Early Start: The earliest a schedule activity is expected to start, based on its relationship to other activities in the Work.

I. Estimated Progress Payments: The scheduled expenditures based on activity cost loading and the anticipated CONTRACTOR gross billings before the withholding of retention; estimated by the CONTRACTOR.

J. Late Finish: The latest a schedule activity can finish based on its relationship to other activities in the Work, and still permit the Work to be completed on time.

K. Late Start: The latest a schedule activity can start based on its relationship to other activities in the Work, and still permit the Work to be completed on time.

L. Milestone: Zero-duration task marking the completion of a significant body of work or important date/event associated with the Contract.

M. Original Duration: The amount of time projected at the beginning of the Work, in days, that an activity was expected to take to complete.

N. Preliminary Progress Schedule: Covers construction related activities from the Notice to Proceed plus the first 30 days of Work.

O. Recovery Schedules: A monthly update of the CLS detailing the necessary recovery activities when a CONTRACTOR has fallen behind on their critical path.

P. Total Float: The number of days by which an activity may be delayed from its early start or finish dates without extending the Substantial Completion date or the Final Completion date.

Q. Unusually Severe Weather: Weather that is more severe than the adverse weather anticipated for the season or location involved.

R. WBS: A tool used to define and group a Project's discrete Work elements in a way that helps organize and define the total Work scope of the Project.

S. Work Activity: An activity that requires time and resources to complete and is required to be performed before the Work is considered complete.

1.4 SEQUENCING AND SCHEDULING

A. Critical Path Network:

1. Utilize the CPM type of scheduling tool to monitor Work progress.
2. Provide information concerning the sequencing, logic, and duration of activities; provide the initial CPM logic network diagram and tabular report data in electronic and paper formats.
3. Utilize the latest version of scheduling software such as Primavera, Microsoft Project, or alternate software approved by the CPM.
4. CPM logic diagrams shall be plotter drawn and submitted on reproducible paper no larger than 24 inches by 36 inches.
5. The activity box shall include, at a minimum, the activity number and description, original duration, and total float; submit logic diagrams until both the preliminary and final CLSs are accepted.
6. Cost load the activities contained within the schedules to equal the Contract Price. Prorate overhead and profit and other incidental costs not identified in other activities on all activities for the entire Project length. Do not unbalance the activity cost loading.

7. Subdivide CMAR and CM/GC contracts by each Bid Package; include the Project fee as a separate activity and do not associate it with other activities.
8. Collect data and information from Subcontractors, Suppliers, and Equipment Manufacturers for incorporation into the CLS.
9. Work activities included in the CLS shall be of sufficient detail to assure adequate planning and execution of the Work such that, in the judgment of the CPM, it provides an appropriate basis for forecasting, monitoring, managing, and evaluating the progress of the Work, making payments for the Work, and starting negotiations for additions and deletions of the Work. Work activities shall conform to the following requirements:
    a. Describe Work activities using consistent terminology such that Work is readily identifiable to assess completion.
    b. Items listed in the Bid Form or Proposal Form shall be reflected in the CLS. These items may be further divided into greater detail to facilitate the management of the Project. The total cost of the rolled up items shall equal the total cost in the Bid Form.
    c. Where the term schedule of values is utilized, it shall be equivalent to the activities of the CLS.
    d. Subdivide the Work into activities of duration no longer than 15 days each, except as to non-construction activities such as the procurement of materials, delivery of materials, delivery of equipment, concrete curing, and other activities for which the CPM may approve a longer duration.
    e. The construction time as determined by the CLS from early start to late finish for any subphase, phase, or the entire Project shall not exceed the Contract Times specified in the Contract Documents; 1 day shall be the smallest time unit shown.
    f. Activities labeled start, continue, or completion are not allowed. Lead and lag time activities will be acceptable only if the description accurately identifies such a restraint and are realistic with respect to the scheduling and sequencing of the Work and overall control schedule of the Work.
    g. Show the following information for each Work activity:
        1) WBS or activity number.
        2) Performance responsibility, Subcontractor, trade code (e.g., General, Mechanical, Electrical, Carpenter, Plasterer).
        3) The duration, in days, and the number of shifts per day as appropriate.
        4) Work location code, descriptive of the physical plant area involved.
        5) Cost data as described herein.
        6) Coding and organization of data and schedule information in accordance with the WBS requirements.
        7) Total float.
    h. Clearly identify and visibly differentiate a single critical path. Sequential Work activities shall be linked logically by precedent/successor activities.
    i. Individual cost loaded activities shall include overhead, profit, and other incidental costs not identified in other activities. CMAR and CM/GC contracts shall be subdivided by each Bid Package. The CONTRACTOR's Project fee shall be included as a separate activity and shall not be associated with other activities.
10. Include the following Milestones in the CLS:
    a. Notice to Proceed: Will be given after the Contract is executed and the Contract bonds and evidence of insurance are approved by the OWNER; do not commence construction activities on the Project site until the Notice to Proceed is issued.
    b. Preliminary progress schedule: Do not commence construction activities on the Project site that affect operations until either the preliminary progress schedule is approved, which includes the first 30 day activities, or specific activities are approved.
    c. Mobilization.
    d. Construction start.
    e. Substantial Completion date.
    f. Specified Milestones, including any intermediate (close-as-you-go) Milestones.
    g. Refocus meeting(s).
    h. Final Completion date.
11. Indicate the sequence and interdependency of Work activities. These include, but are not limited to, the following items as appropriate to the Contract:
    a. Submittal preparation by the CONTRACTOR and review by the CPM.
    b. Material and equipment (early start/finish dates and late start/finish dates):
        1) Supplier submittal/acceptance.
        2) Shop Drawing submittal/acceptance.
        3) Release for fabrication.
        4) Fabrication period.
        5) Witness shop test (if applicable).
        6) Delivery.
        7) Installation.
        8) Check out.
        9) Spare parts delivery.
        10) O&M manuals: Preliminary O&M, Final O&M predecessor to start-up/commissioning; value for both shall be 5% each of the sum of the total equipment cost and the installation cost of the equipment or system. The ENGINEER may increase the percentage, if necessary, to a maximum of 10%.

11) Lesson plans submittal/acceptance.
12) Training.

c. Shop and field performance tests and supervisory service activities.
d. Mobilization and move in.
e. Preparation of coordination and layout drawings.
f. Environmental constraints: Show significant elements of the construction stormwater and pollution prevention plans; elements may include, but are not limited to, the installation and removal of erosion/sedimentation controls and stormwater control; consider any restrictions on the Work due to permits related to environmental restrictions.
g. Obtaining required permits and complying with permit conditions.
h. Specific Work activities including, but not limited to: Demolition, sitework, excavation, underground pipe installation, structural excavation, soil testing, backfill, placement of sheeting, pile driving, formwork erection, rebar placement, placing of concrete, stripping forms, concrete curing, installation of fiber optic conduits, terminations, other materials and equipment, re-vegetation, and clean up.
i. Construction of the facilities outlined in the Contract Documents.
1) Allowances and contingency work activities.
j. Subcontractor's items of Work.
k. Time allowance for unusually severe weather.
l. DW observed holiday schedule.
m. Punchlists.
n. Final cleanup.
o. Time allowance for testing.
p. Time allowance for startup and commissioning.
q. Contract activity interface coordination with other contractors, Substantial Completion date and Final Completion date, and the maintenance of operations of existing plant(s).
r. Indicate coordination activities from related construction contracts.
s. Connection to existing plant systems and equipment.
t. Preparation of final copies of the CONTRACTOR’s redline drawings, AutoCAD As-Built Drawings, and Record Documents.
u. Temporary utilities and construction.
v. Required inspections.
w. Preparation, submittal, and approval of O&M manuals and redline Drawings.
x. Demobilization.
y. Project closeout.

12. Develop other activity codes and values needed to comply with the reporting requirements listed herewith, subject to acceptance by the CPM.

B. Time Extension for Unusually Severe Weather:

1. Upon written request from the CONTRACTOR, the CPM may suspend the counting of Contract Time, herein called time extension, for the CONTRACTOR's convenience during unusually severe weather. The CONTRACTOR's request for the time extension shall clearly demonstrate that weather conditions are unusually severe (i.e., more severe than the adverse weather anticipated for the Project location during any given month) and that such conditions adversely affected 50% or more of the CONTRACTOR's workday and delayed Work critical to the timely completion of the Project.
2. The following schedule of monthly anticipated adverse weather delays is based on NOAA for Denver based and Front Range Projects (elevation 7,200 feet and below):

Month	Calendar Days
January	7
February	4
March	4
April	4
May	6
June	3
July	4
August	2
September	3
October	3
November	4
December	5

3. For Projects located outside of Denver and Front Range areas (above elevation 7,200 feet), adverse weather delays will be greater than those listed herein. If the CONTRACTOR requests a time extension for unusually severe weather at these Project locations, determine the number of adverse weather delays specific to the location

by analysis of NOAA or other weather data. The last 10 years of consecutive data shall be used to establish the baseline whenever possible.

4. Only the number of days lost due to unusually severe weather, as requested by the CONTRACTOR and approved by the CPM, that exceed the anticipated adverse weather delays for the month, will be considered for granting a Contract Time extension. The delay needs to be beyond the control and without the fault or negligence of the CONTRACTOR.
5. The CONTRACTOR's CLS shall incorporate these anticipated adverse weather delays in weather dependent activities.
6. If the CONTRACTOR elects not to perform the Work during periods of adverse inclement weather that does not qualify as unusually severe weather, the CONTRACTOR will not be entitled to an extension of time.
7. If warranted, a time extension for unusually severe weather will be implemented by Change Order. Costs resulting from the time extension including, but not limited to, the protection and maintenance of the jobsite, maintaining specified insurance and bonding certificates, and traffic control for the period of the time extension shall be the responsibility of the CONTRACTOR and shall be at no additional cost to the OWNER. Unit price adjustments or special allowances will not be paid by the OWNER for escalated material, labor, equipment, or any other costs associated with the time extension.

C. Preliminary Progress Schedule:
1. No later than 10 days after the Notice to Proceed, submit the preliminary progress schedule containing the following information:
   a. Procurement activities: Prepare submittals and Shop Drawings, CPM's review and comment, fabrication and delivery, and shop testing.
   b. The Project's critical path.
   c. Each building and each areas major sequences of Work.
   d. Preliminary estimated progress payments for the total Project.
   e. Scheduled activities for the first 30 days of Work in reasonable conformity to the Contract Documents; the remaining CLS shall show the CLS using broad Work activities and major Milestones and durations for the purpose of review and discussion at the Pre-Construction Meeting.

D. CLS:
1. No later than 30 days after the Notice to Proceed, submit the CLS demonstrating the final level of detail for each activity, containing the required relationships completely identified, and correctly depicting the duration of each activity. The CLS shall be composed of:
   a. A complete logic and activity duration schedule at the final level of detail for each activity, containing the required relationships completely identified and the duration of each activity correctly depicted.
   b. No Contract changes or delays which may have been incurred during the CLS development period; enter these at the first update after the CLS has been accepted.
   c. Cost information assigned to each of the specific activities at the final level of detail; each activity shall be cost loaded to permit the initial and monthly generation of an estimated progress payment curve, the construction schedule of values, a resource curve, and to assess the progress of the Work. Monthly payment applications shall be submitted as specified in SECTION 01 29 00.
2. If the CLS is not accepted, revise it in accordance with the CPM's comments and resubmit it within 7 days.
3. When the CLS is accepted it becomes the baseline CLS for schedule of record and the basis for future schedule updates, and for determining change order costs, schedule impacts, and delays. After the baseline CLS is approved by the OWNER, the approved baseline CLS will be used to determine cost or delay impacts associated with changes. Work associated with allowances and contingencies shall be included as an activity in the baseline CLS and scheduled to be complete in accordance with the contractual Milestones/completion dates. The Work associated with allowances and contingencies shall be completed in a reasonable amount of time and any CONTRACTOR-imposed delays may not be included within an allowance or contingency.
4. After acceptance of the CLS, no changes are allowed without the approval of the CPM.
5. The CONTRACTOR is not entitled to any damages by reason of the failure of the CPM to give timely acceptance or comments on any CLS hereunder.
6. Payment requests:
   a. The first payment request will be processed if the CLS has been submitted by the CONTRACTOR and returned by the CPM with the corrections noted with the understanding that the corrections will be made.
   b. The second payment request and subsequent requests will be processed for payment only if the CLS has been submitted by the CONTRACTOR and returned by the CPM with no corrections required.

E. Progress of the Work:
1. If at any time during the Work, the CONTRACTOR fails to complete any activity by its latest completion date, the CONTRACTOR is required, within 7 days, to submit to the CPM a written statement as to how and when the CONTRACTOR plans to reorganize the work force, re-schedule the Work and recovery, and the potential schedule delay during the next CLS update period.
   a. Actions by the CONTRACTOR to complete Work within Contract Times or Milestones will not be a justification for adjustment to Contract Price or Contract Times.
   b. The ENGINEER may order the CONTRACTOR to increase plant, equipment, labor force, or working hours if, due solely to the CONTRACTOR's own operations, the CONTRACTOR fails to:
      1) Complete critical scheduled activity by its latest Milestone completion date.

2) Satisfactorily execute Work to prevent delay to the overall completion of the Work, at no additional cost to the OWNER.

2. Monthly CLS updates:
   a. After the baseline CLS is accepted by the CPM, prepare and submit monthly update information on logic, physical percent complete, actual start and finish dates, duration changes, and related reports, diagrams, and schedules.
   b. Subsequent monthly updates will be compared to the baseline CLS. Compare each current monthly update to the last month's update. Label each update by period with the data date and the report date identified on the hardcopy and electronic file label.
   c. Include the following with the baseline CLS:
      1) Certification that the CLS is being utilized for the management and execution of the Work and that Subcontractors with 10% or more of the Work concur with the CLS.
      2) Comparison of the baseline CLS activities against current update activities.
      3) Clearly identify critical path and near critical paths.
      4) Narrative report.
      5) Estimated progress payments by month with early and late forecast CLS dates and showing actual expenditures from previous months.
      6) Successor/predecessor, total float, and 90-day-look-ahead reports.
      7) A detailed monthly cost activity report, reflecting the actual costs for the period, costs-to-date, and budgeted costs.
      8) A monthly summary cost activity report oriented to the monthly payment requisition level of detail.
   d. Provide monthly updates with the request for progress payment. The CPM will have the right to withhold payment until the monthly update(s) are received. Default progress data provided from the scheduling system are not allowed. Actual start and finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems.
   e. Activities that have reported progress without predecessor activities being completed (out-of-sequence progress) are not allowed except on a case-by-case basis with approval from the CPM. A written explanation of each activity shall be included in the monthly submittal. The CPM may direct that changes in CLS logic be made to correct any out-of-sequence Work.
   f. Each month, identify any changes to the CLS such as new activities, deleted activities, activity duration changes, activity description changes, and change in logic relationships between activities. Describe logic changes and include an explanation of the rationale for the change.
   g. Do not constrain the CLS with artificial logic ties, constraint dates, or any other scheduling techniques that may distort the activity float and total float associated with the critical path activities and the CLS in general.
   h. Provide a CLS defining the times at which equipment, materials, means, and methods require submittals. The submittal CLS shall be tied to early start/early finish and late start/late finish dates to ensure time has been allowed for review and return.

F. CLS End Float:
   1. The difference in time between the Project's scheduled early completion date, as submitted, and the required Contract completion date will be considered as float. Float and total float within the CLS are not for the exclusive use of the OWNER or the CONTRACTOR; they are jointly owned by both parties and are a resource available to be shared as needed to meet Contract Milestones and the Contract completion date.
   2. Do not sequester shared float though such strategies as extending the activity duration estimates to consume available float, using preferential logic, or using extensive crew/resource sequencing, etc. Since float time within the CLS is jointly owned, no time extension will be granted unless the critical path of the CLS is affected which extends Work beyond the Contract completion date.
   3. Early completion CLSs are generally not acceptable to the OWNER but may be accepted as a convenience to the CONTRACTOR under the following conditions:
      a. Submit a written request outlining the specific reasons for using the early completion CLS.
      b. Acknowledge and agree, in writing, that the proposed reduction in time represents Contract Time already paid for by the OWNER as part of the Contract Price and is available to both the CONTRACTOR and the OWNER for the mitigation of impacts to the Work from any source. The CONTRACTOR will not be entitled to any increase in Contract Price for failure to achieve early completion and the CONTRACTOR waives all claims to the same.
      c. The early completion CLS will not be based on expedited approvals, inspection, or the relaxing of construction constraints by the OWNER.
      d. Early completion CLSs will meet all other Contract requirements.
      e. Acknowledge and agree, in writing, that the OWNER has the right to withhold the final payment due to the CONTRACTOR until the contractual end date.
      f. Early completion CLS updates which contain activities that are behind schedule will be revised when requested by the CPM.

G. Monthly Progress Meeting and Reports:
   1. Once each month, on a date established by the CPM, a progress meeting will be held at which time the CLS will be reviewed. The meeting will be attended by the CPM, the OWNER Consultants, the ENGINEER, the CONTRACTOR, and the Subcontractor's Representatives for the Contract.

2. The CONTRACTOR's Representative(s) at the meetings shall have the competence and authority to make any necessary decisions and their statement shall commit the CONTRACTOR to the agreed procedures, sequence of Work activities, operations, and time schedules.
3. The updated CLS shall be furnished to the CPM electronically at least 2 days prior to the meeting and shall be available in hardcopy at the meeting for review. To update the CLS, the CONTRACTOR shall:
    a. Obtain from each Subcontractor the necessary information to update the CLS to reflect the progress to date and to update the CLS for the balance of the Work.
    b. Enter the actual start and completion dates for those activities started and completed during the previous reporting period.
    c. For activities in progress, indicate the remaining duration correlating to an accurately forecasted completion date and the physical percentage complete to date. Review and revise, as necessary, the network logic for the remaining duration of the Work from the update to the estimated completion date.
    d. For activities not yet started, review and revise, as required, the necessary logic for the duration and the estimated start and completion dates.
    e. Enter the actual installed quantities information and corresponding cost information for each applicable activity.
    f. Add identified Contract modification activities.
    g. Annotate updated status information on the CLS in a manner that graphically depicts the current status of the Work.
4. If discrepancies regarding data/information accuracy be noted during the review meeting or other discussions, the CPM may direct the CONTRACTOR to adjust the percentage complete, the remaining duration, and the actual dates to selected activities and re-issue the updated CLS and cost reports.
5. Failure to submit the CLS, subsequent updates, or previously requested corrections of the CLS within 7 days of the update meeting will be considered cause for withholding partial payments due or that may become due under the Contract.

H. Recovery Schedules for CLS:
1. Delays to critical path: Whenever it becomes apparent from the current monthly update that delays to the critical path have resulted and such delays are through no fault of the OWNER or the ENGINEER and hence, that the Contract completion date will not be met, or when so directed by the CPM, take some or all of the following actions at no additional cost to the OWNER:
    a. Increase resources in such quantities and crafts as will substantially eliminate the backlog of Work.
    b. Increase working hours per shift, shifts per day, or working days per week, the amount of construction equipment, or any combination of the foregoing to substantially eliminate the backlog of Work.
    c. Reschedule activities to achieve the maximum practical concurrence of accomplishment of activities and comply with the revised CLS.
2. Under no circumstances will the addition of equipment, construction forces, increasing the working hours, or any other method, manner, or procedure to return to the CLS be considered justification for Contract modification or extra Work.
3. Failure of the CONTRACTOR to recover the CLS time frames as set forth in this agreement will be considered to be a material breach of the Contract. Thereupon, the OWNER will have the right to remove any or all of the remaining Work from the CONTRACTOR's scope and to complete such Work, by whatever method the OWNER may deem expedient, including employing another contractor or contractors under such form of contract as the OWNER may deem advisable, or the OWNER may itself provide labor or materials and perform any part of such Work at its option. The CONTRACTOR agrees that the OWNER will have the right to take possession of and to use any or all of the materials, plant, tools, goods, supplies, and property of any and every kind furnished by the CONTRACTOR for such Work. The expense of so completing such Work, together with a reasonable charge for administering any contract for such completion, will be charged to the CONTRACTOR, and such expense will be deducted by the OWNER out of such monies as may be due or may at any time thereafter become due to the CONTRACTOR. In case such expense exceeds the sum which would have otherwise been payable under the Contract, then the CONTRACTOR and it sureties will be liable for and shall, upon notice from the OWNER, promptly pay to the OWNER the amount of the increase in cost of doing the Work.
4. The CPM may require the CONTRACTOR, at any time during the Work, to develop a more detailed CLS to provide a clearer understanding of the effort needed to complete a specific area or task.

I. Float Ownership:
1. Without obligation to extend the overall completion date or any intermediate completion dates set out in the CLS, the CPM may initiate changes to the Work that absorb float time only. CONTRACTOR-initiated changes that encroach on the float time identified in the CLS may be accomplished with the CPM's written approval.
2. OWNER-initiated changes that extend or shorten the Contract Times will be the sole basis to adjust the Contract completion date. Delays in the critical path not associated with proper requests for time extensions in accordance with the General Conditions will be deemed to be the responsibility of the CONTRACTOR.

1.5 SUBMITTALS
A. Submit an electronic file, PDF version, and three copies of sufficient size to clearly read the information.
B. Cost and Narrative Progress Reports:
1. Prepare and submit a detailed and summary cost activity report each month. The cost information shall be updated by activity and summarized for each month. The sum of monthly costs shall be equal to the Contract

Price plus approved Change Orders. The updated cost information shall be consistent with the payment amounts requested via the payment requisition.

2. Summarize the costs for each month; the sum of the monthly costs shall be equal to the Contract Price.
3. The narrative report shall include (in the following sequence):
   a. The CONTRACTOR's transmittal letter.
   b. A report indicating each activity on the CLS:
      1) Completed during this reporting period.
      2) In progress during this reporting period.
      3) Scheduled for the next reporting period.
   c. An analysis, by critical path, of each negative path describing:
      1) The nature of the critical path.
      2) The impact on other activities, Milestones, and completion dates.
      3) Recommendations for recovery of the delays.
   d. Current and anticipated delays including:
      1) The cause of the delay.
      2) Corrective action and CLS adjustments to correct the delay.
      3) The impact of the delay on other activities, Milestones, and completion dates.
   e. Change in construction sequence, logic changes, relationship changes, or duration changes, and the rationale associated with each change that required the change to be made.
   f. Pending issues and the status of other items:
      1) Permits.
      2) Contract modifications.
      3) Time extension requests.
      4) Long lead procurement items.
   g. Tabulated by:
      1) CONTRACTOR/early start.
      2) Total float/early start.
      3) Area/early start.
      4) Activity number.
   h. Added/deleted activities.
   i. An out-of-sequence report describing the necessity of each activity relationship shown therein.
   j. Illogical progress/restraint reports.
   k. Contract complete date status.
   l. Ahead of schedule and number of days.
   m. Behind schedule and number of days.
   n. A summary of Project cost data by appropriate breakdown including budget quantity, cost, percent complete, actions to date, actions this period, the estimate to complete, and variance.
   o. A summary of Project status including cumulative information to date, variance, and forecast at completion.
   p. Other Project or scheduling concerns.
   q. Review and update of CLS.
   r. Safety reports and any code violations or warnings.

C. Submit a 3-week-look-ahead-schedule that includes the week in which the schedule is presented plus the two successive weeks. The 3-week-look-ahead-schedule shall be derived from the CLS but contains more specific on-going and new Work activities. Submit the schedule to the CPM no later than 2 days prior to the weekly Project progress meeting.

D. Submit a written statement of the intended steps to remove or arrest the delay to the CLS to the CPM. Promptly provide such level of effort to bring the Work back on schedule. If schedule delays persist, the CONTRACTOR’s surety may be asked to attend CLS update meetings.

1.6 QUALITY ASSURANCE

A. Qualifications: Provide a trained and experienced construction scheduling person knowledgeable in construction work sequencing, productivity, scheduling, and application of the scheduling software system.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 32 16.02
COST LOADED SCHEDULE (FOR LESS-COMPLEX PROJECTS)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for cost loaded schedules.

B. Related Sections:

1. SECTION 01 29 00 – PAYMENT PROCEDURES

1.2 PRICE AND PAYMENT PROCEDURES

A. Payment Deductions: A permanent line-item deduction, at the pro-rata rate of $750 per month, will be deducted from the Contract Price if, in the judgment of the CPM, the CONTRACTOR is deemed to be the cause for the delay in submitting the CLS or subsequent monthly updates as discussed in monthly progress meetings and reports. The CONTRACTOR will be notified within 1 week of said delinquency that the permanent deduction is being assessed against the Contract.

1.3 DEFINITIONS

A. 3-Week-Look-Ahead-Schedule: A schedule derived from the CLS that includes the week in which the schedule is presented plus the next two successive weeks.

B. Adverse Weather: Atmospheric conditions at a definite time and place that are unfavorable to construction activities.

C. Cash Flow: Synonymous with Estimated Progress Payments.

D. CLS: A detailed schedule of individual activities required to complete the Work and their associated cost that the CONTRACTOR anticipates requesting partial payment for as the Work is progressively completed. References to schedule or construction schedule mean CLS; activities and total associated costs in the CLS shall be equal to the Contract Price.

E. Construction Schedule of Values: Allocates values for the various parts of the Work (activities, or groups of activities/categories) used as the basis for submitting and reviewing progress payments.

F. Critical Path: A series of sequentially linked activities in a Project schedule that will take the longest total amount of time to complete. At any point in time, the critical path will be the path with the least amount of total float.

G. Early Finish: The earliest a schedule activity is expected to finish based on its relationship to other activities in the Work.

H. Early Start: The earliest a schedule activity is expected to start based on its relationship to other activities in the Work.

I. Estimated Progress Payments: The scheduled expenditures based on activity cost loading and the anticipated CONTRACTOR gross billings before the withholding of retention; estimated by the CONTRACTOR.

J. Late Finish: The latest a schedule activity can finish, based on its relationship to other activities in the Work, and still permit the Work to be completed on time.

K. Late Start: The latest a schedule activity can start, based on its relationship to other activities in the Work, and still permit the Work to be completed on time.

L. Milestone: Zero-duration task marking the completion of a significant body of work or important date/event associated with the Contract.

M. Original Duration: The amount of time projected at the beginning of the Work, in days, that an activity was expected to take to complete.

N. Preliminary Progress Schedule: Covers construction related activities from the Notice to Proceed plus the first 30 days of Work.

O. Recovery Schedules: A monthly update of the CLS detailing the necessary recovery activities when a CONTRACTOR has fallen behind on their critical path.

P. Total Float: The number of days by which an activity may be delayed from its early start or finish dates without extending the Substantial Completion date or the Final Completion date.

Q. Unusually Severe Weather: Weather that is more severe than the adverse weather anticipated for the season or location involved.

R. Work Activity: An activity that requires time and resources to complete and is required to be performed before the Work is considered complete.

1.4 SEQUENCING AND SCHEDULING

A. Critical Path Network:

1. Utilize the CPM type of scheduling tool to monitor Work progress.
2. Provide information concerning the sequencing, logic, and duration of activities.
3. Utilize the latest version of scheduling software such as Primavera, Microsoft Project, or alternate software approved by the CPM.
4. The activity box shall include, at a minimum, the activity number and description, original duration, start date and end date, and total float; submit logic diagrams until both the preliminary and final CLSs are accepted.
5. Collect data and information from Subcontractors, Suppliers, and Equipment Manufacturers for incorporation into the CLS.
6. Work activities included in the CLS shall be of sufficient detail to assure adequate planning and execution of the Work such that, in the judgment of the CPM, it provides an appropriate basis for forecasting, monitoring, managing, and evaluating the progress of the Work, making payments for the Work (construction schedule of values), and starting negotiations for additions and deletions of the Work. Work activities shall conform to the following requirements:
   a. Describe Work activities using such that Work activities are readily identifiable.

b. The construction time as determined by the CLS from start to finish shall not exceed the Contract Times specified in the Contract Documents; 1 day shall be the smallest time unit shown.
c. Show the following information for each Work activity:
    1) Activity number and description.
    2) Performance responsibility, Subcontractor, trade code (e.g., General, Mechanical, Electrical, Carpenter, Plasterer).
    3) The duration, in days, and the number of shifts per day as appropriate.
    4) The start and finish days for the activity.
    5) Predecessor and successor activities.
    6) Total Float.
d. Clearly identify a single critical path. Sequential Work activities shall be linked logically by precedent/successor activities.

7. Include the following Milestones in the CLS:
    a. Notice to Proceed: Will be given after the Contract is executed and the Contract bonds and evidence of insurance are approved by the OWNER; do not commence construction activities on the Project site until the Notice to Proceed is issued and the preliminary progress schedule, which includes the first 30 day activities, is submitted and approved.
    b. Mobilization.
    c. Construction start.
    d. Substantial Completion date.
    e. Milestones, including any intermediate (close-as-you-go) Milestones.
    f. Final Completion date.
8. Indicate the sequence and interdependency of Work activities. These include, but are not limited to, the following items as appropriate to the Contract:
    a. Submittal preparation by the CONTRACTOR and review by the CPM.
    b. Material and equipment:
        1) Submittals and Shop Drawing generation and acceptance.
        2) Fabrication period.
        3) Delivery.
        4) Installation.
        5) O&M manuals: Preliminary O&M, Final O&M predecessor to startup/commissioning; value for both shall be 5% each of the sum of the total equipment cost and the installation cost of the equipment or system. The ENGINEER may increase the percentage, if necessary, to a maximum of 10%.
    c. Shop and field performance tests and supervisory service activities.
    d. Mobilization.
    e. Preparation of coordination and layout drawings.
    f. Environmental constraints such as the installation and removal of erosion/sedimentation controls and stormwater control.
    g. Obtaining required permits and complying with all permit conditions.
    h. Specific Work activities including, but not limited to: Demolition, sitework, excavation, underground pipe installation, structural excavation, soil testing, backfill, placement of sheeting, pile driving, formwork erection, rebar placement, placing of concrete, stripping forms, concrete curing, installation of fiber optic conduits, terminations, other materials and equipment, re-vegetation, and clean up.
    i. Construction of the facilities outlined in the Contract Documents.
        1) Allowances and contingency work activities.
    j. Subcontractor's items of Work.
    k. Time allowance for unusually severe weather.
    l. DW observed holiday schedule.
    m. Punchlists.
    n. Final cleanup.
    o. Time allowance for testing.
    p. Time allowance for startup and commissioning.
    q. Contract activity interface coordination with other contractors, Substantial Completion date and Final Completion date, and the maintenance of operations of existing plant(s).
    r. Indicate coordination activities from related construction contracts.
    s. Connection to existing plant systems and equipment.
    t. Preparation of final copies of the CONTRACTOR’s redline drawings, AutoCAD As-Built Drawings, and Record Documents.
    u. Temporary utilities and construction.
    v. Required inspections.
    w. Preparation, submittal, and approval of O&M manuals and redline Drawings.
    x. Demobilization.

B. Project Closeout Time Extension for Unusually Severe Weather:
    1. Upon written request from the CONTRACTOR, the CPM may suspend the counting of Contract Time, herein called time extension, for the CONTRACTOR's convenience during unusually severe weather. The CONTRACTOR's request for the time extension shall clearly demonstrate that weather conditions are unusually severe (i.e., more

severe than the adverse weather anticipated for the Project location during any given month) and that such conditions adversely affected 50% or more of the CONTRACTOR's workday and delayed Work critical to the timely completion of the Project.

2. The following schedule of monthly anticipated adverse weather delays is based on NOAA for Denver based and Front Range Projects (elevation 7,200 feet and below):

Month	Calendar Days
January	7
February	4
March	4
April	4
May	6
June	3
July	4
August	2
September	3
October	3
November	4
December	5

3. For Projects located outside of Denver and Front Range areas (above elevation 7,200 feet), adverse weather delays will be greater than those listed herein. If the CONTRACTOR requests a time extension for unusually severe weather at these Project locations, determine the number of adverse weather delays specific to the location by analysis of NOAA or other weather data. The last 10 years of consecutive data shall be used to establish the baseline whenever possible.
4. Only the number of days lost due to unusually severe weather, as requested by the CONTRACTOR and approved by the CPM, that exceed the anticipated adverse weather delays for the month, will be considered for granting a Contract Time extension. The delay needs to be beyond the control and without the fault or negligence of the CONTRACTOR.
5. If the CONTRACTOR elects not to perform the Work during periods of adverse inclement weather that does not qualify as unusually severe weather, the CONTRACTOR will not be entitled to an extension of time.
6. If warranted, a time extension for unusually severe weather will be implemented by Change Order. Costs resulting from the time extension including, but not limited to, the protection and maintenance of the jobsite, maintaining specified insurance and bonding certificates, and traffic control for the period of the time extension shall be the responsibility of the CONTRACTOR and shall be at no additional cost to the OWNER. Unit price adjustments or special allowances will not be paid by the OWNER for escalated material, labor, equipment, or any other costs associated with the time extension.

C. Preliminary Progress Schedule:
   1. No later than 10 days after the Notice to Proceed, submit the preliminary progress schedule containing the following information:
      a. Procurement activities: Prepare submittals and Shop Drawings, CPM’s review and comment, fabrication and delivery, and shop testing.
      b. The Project’s critical path.
      c. Scheduled activities for the first 30 days of Work in reasonable conformity to the Contract Documents; the remaining CLS shall show the critical path schedule using broad Work activities and major Milestones and durations for the purpose of review and discussion at the Pre-Construction Meeting.

D. CLS:
   1. No later than 30 days after the Notice to Proceed, submit the CLS demonstrating the final level of detail for each activity, containing the required relationships completely identified, and correctly depicting the duration of each activity. The CLS shall be composed of:
      a. A complete logic and duration schedule at the final level of detail for each activity, containing the required relationships completely identified and the duration of each activity correctly depicted.
      b. No Contract changes or delays which may have been incurred during the interim schedule development period; enter these at the first update after the CLS has been accepted.
      c. Cost information assigned to each of the specific activities is not necessarily needed at the final level of detail; however, each activity or group of activities shall be cost loaded and provides the basis to complete the construction schedule of values. Monthly payment applications shall be submitted as specified in SECTION 01 29 00.
   2. If the CLS is not accepted, revise it in accordance with the CPM’s comments and resubmit it within 7 days.
   3. When the CLS is accepted it becomes the baseline CLS for schedule of record and the basis for future schedule updates, and for determining change order costs, schedule impacts, and delays. After the baseline CLS is approved by the OWNER, the approved baseline CLS will be used to determine cost or delay impacts associated with changes. Work associated with allowances and contingencies shall be included as an activity in the baseline CLS and scheduled to be complete in accordance with the contractual Milestones/completion dates. The Work

associated with allowances and contingencies shall be completed in a reasonable amount of time and any CONTRACTOR-imposed delays may not be included within an allowance or contingency.
4. After acceptance of the CLS, no changes are allowed without the approval of the CPM.
5. The CONTRACTOR is not entitled to any damages by reason of the failure of the CPM to give timely acceptance or comments on any CLS hereunder.

E. Progress of the Work:
1. If at any time during the Work, the CONTRACTOR fails to complete any activity by its latest completion date, the CONTRACTOR is required, within 7 days, to submit to the CPM a written statement as to how and when the CONTRACTOR plans to reorganize the work force, re-schedule the Work and recovery, and the potential schedule delay during the next CLS update period.
   a. Actions by the CONTRACTOR to complete Work within Contract Times or Milestones will not be a justification for adjustment to Contract Price or Contract Times.
2. Monthly CLS updates:
   a. After the baseline CLS is accepted by the CPM, prepare and submit monthly update information on logic, physical percent complete, actual start and finish dates, duration changes, and related reports, diagrams, and schedules.
   b. Subsequent monthly updates will be compared to the baseline CLS. Compare each current monthly update to the last month's update. Label each update by period with the data date and the report date identified on the hardcopy and electronic file label.
   c. Provide monthly updates with the request for progress payment. The CPM will have the right to withhold payment until the monthly update(s) are received. Default progress data provided from the scheduling system are not allowed. Actual start and finish dates shall not be automatically updated by default mechanisms that may be included in CPM scheduling software systems.
   d. Activities that have reported progress without predecessor activities being completed (Out-of-Sequence Progress) are not allowed except on a case-by-case basis with approval from the CPM. A written explanation of each activity shall be included in the monthly submittal. The CPM may direct that changes in CLS logic be made to correct any out-of-sequence Work.
   e. Each month, identify any changes to the CLS such as new activities, deleted activities, activity duration changes, activity description changes, and change in logic relationships between activities. Describe logic changes and include an explanation of the rationale for the change.
   f. Do not constrain the CLS with artificial logic ties, constraint dates, or any other scheduling techniques that may distort the activity float and total float associated with the critical path activities and the CLS in general.

F. 3-Week-Look-Ahead: Provide a 3-week-look-ahead-schedule that includes the week in which the schedule is presented plus the two successive weeks. The 3-week-look-ahead-schedule shall be derived from the CLS but contains more specific on-going and new Work activities. Submit the schedule to the CPM no later than 2 days prior to the weekly Project progress meeting.

G. Monthly Progress Meeting and Reports:
1. Once each month, on a date established by the CPM, a progress meeting shall be held at which time the CLS will be reviewed. The meeting will be attended by the CPM, the OWNER Consultants, the ENGINEER, the CONTRACTOR, and the Subcontractor's Representatives for the Contract.
2. The CONTRACTOR's Representative(s) at the meetings shall have the competence and authority to make any necessary decisions and their statement shall commit the CONTRACTOR to the agreed procedures, sequence of Work activities, operations, and time schedules.
3. The updated CLS shall be furnished to the CPM electronically at least 2 days prior to the meeting and shall be available in hardcopy at the meeting for review. To update the CLS, the CONTRACTOR shall:
   a. Obtain from each Subcontractor the necessary information to update the CLS to reflect the progress to date and to update the CLS for the balance of the Work.
   b. Enter the actual start and completion dates for those activities started and completed during the previous reporting period.
   c. For activities in progress, indicate the remaining duration correlating to an accurately forecasted completion date and the physical percentage complete to date. Review and revise, as necessary, the network logic for the remaining duration of the Work from the update to the estimated completion date.
   d. Add identified Contract modification activities.
4. Failure to submit the CLS, subsequent updates, or previously requested corrections of the CLS within 7 days of the update meeting will be considered cause for withholding partial payments due or that may become due under the Contract.

H. Remedial and Recovery Schedules for CLS:
1. Delays to critical path: Whenever it becomes apparent from the current monthly update that delays to the critical path have resulted and such delays are through no fault of the OWNER or the ENGINEER and hence, that the Contract completion date will not be met, or when so directed by the CPM, take some or all of the following actions at no additional cost to the OWNER:
   a. Increase resources in such quantities and crafts as will substantially eliminate the backlog of Work.
   b. Increase working hours per shift, shifts per day, or working days per week, the amount of construction equipment, or any combination of the foregoing to substantially eliminate the backlog of Work.
   c. Reschedule activities to achieve the maximum practical concurrence of accomplishment of activities and comply with the revised CLS.

2. Submit a written statement of the intended steps to remove or arrest the delay to the CLS to the CPM. Promptly provide such level of effort to bring the Work back on schedule. If schedule delays persist, the CONTRACTOR's surety may be asked to attend CLS update meetings.
3. Under no circumstances will the addition of equipment, construction forces, increasing the working hours, or any other method, manner, or procedure to return to the CLS be considered justification for Contract modification or extra Work.
4. The CPM may require the CONTRACTOR, at any time during the Work, to develop a more detailed CLS to provide a clearer understanding of the effort needed to complete a specific area or task.

I. Float Ownership:
1. Without obligation to extend the Final Completion date or any intermediate completion dates (e.g., Milestones, Substantial Completion date) set out in the CLS, the CPM may initiate changes to the Work that absorb float time only. CONTRACTOR-initiated changes that encroach on the float time identified in the CLS may be accomplished with the CPM's written approval.
2. OWNER-initiated changes that extend or shorten the Contract Times will be the sole basis to adjust the Contract completion date. Delays in the critical path not associated with proper requests for time extensions in accordance with the General Conditions will be deemed to be the responsibility of the CONTRACTOR.

1.5 SUBMITTALS
A. Submit an electronic file, PDF version, and three copies of sufficient size to clearly read the information.
B. Estimated Progress Payments:
1. Prepare and submit a progress payment estimate within 10 days from the issuance of Notice to Proceed. The estimated progress payments shall show the estimated costs incurred for each month of the Work, based upon the activities being performed in that month. The sum of the monthly costs shall be equal to the Contract Price plus approved Change Orders.
2. Update the estimated progress payments on a quarterly basis, showing actual expenditures from previous months. The updated progress payments estimate shall be consistent with anticipated future payment amounts.

1.6 QUALITY ASSURANCE
A. Qualifications: Provide a trained and experienced construction scheduling person knowledgeable in construction work sequencing, productivity, scheduling, and application of the scheduling software system.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 32 20
ELECTRONIC DOCUMENT MANAGEMENT SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for the electronic document management system.

B. Related Sections:

1. SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION
2. SECTION 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION
3. SECTION 01 33 00 – SUBMITTAL PROCEDURES

1.2 SUBMITTALS

A. Administer submittals in the EDMS which are specified in SECTION 01 33 00.

1.3 QUALITY ASSURANCE

A. Computer Requirements: Use computer hardware and software that meets the requirements of the EDMS system as recommended by the Manufacturer. As recommendations are modified by the Manufacturer, the CONTRACTOR will upgrade their system(s) to meet the recommendations or better. Upgrading of the CONTRACTOR's computer systems will not be justification for a cost or time modification to the Contract. Ensure that connectivity to the EDMS system is accomplished through DSL, cable, T-1, or wireless communications systems. The minimum bandwidth requirements for using the system shall be as required by the Software Manufacturer. It is recommended that a faster connection be used when uploading pictures and files into the system.

B. The OWNER and the CONTRACTOR shall use an EDMS for electronic submittal of data and documents throughout the duration of the Contract. The EDMS shall be a web-based electronic media site that is approved by the OWNER. The EDMS will be made available to CONTRACTOR Project personnel, Subcontractor personnel, Suppliers, Consultants, and the designer of record. The joint use of the system is to facilitate the electronic exchange of information, the automation of key processes, and the overall management of the Contract. The EDMS is the primary means of Project information submission and management. When required by the ENGINEER, provide paper documents. In the event of a discrepancy between the electronic version and the paper documents, the paper documents will govern.

C. CONTRACTOR Responsibility:

1. The CONTRACTOR is responsible for the validity of their information placed in the EDMS and for the abilities of their personnel. Accepted users are required to be knowledgeable in the use of computers, including internet browsers, email programs, AutoCAD drawing applications, and PDF document distribution programs. Use the existing forms in the EDMS to the maximum extent possible. If a form does not exist in the EDMS, the CONTRACTOR shall include a form of their own or one provided by the ENGINEER as an attachment to a Submittal. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The CONTRACTOR is responsible for the training of their personnel in the use of the EDMS (in addition to any training provided by the OWNER) and the other programs indicated above as needed.
2. User access administration: Provide a list of the CONTRACTOR's key personnel that will be using the EDMS for the ENGINEER's acceptance. The CONTRACTOR is responsible for adding and removing users from the system. The ENGINEER reserves the right to perform a security check on potential users. The CONTRACTOR is allowed to add additional personnel and Subcontractors to the EDMS.

D. Training: The OWNER has arranged for training to be provided to the CONTRACTOR and will schedule the training at the Pre-Construction Meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 APPLICATION

A. User Access Limitations:

1. The OWNER will provide a web-based software system to submit and manage most construction-related documents for this Project. The software currently in use (as of 2021) is Procore; licensing and access will be supplied by DW. The OWNER may elect to use other software at its discretion. Administer but not be limited to the following documents in the EDMS: Submittals, RFIs, punch list, inspections and observations, meetings, photos, and documents.
2. This is an OWNER-provided system to submit and manage most construction-related documents for this Project.
3. The ENGINEER will control the CONTRACTOR's access to the EDMS by allowing access and assigning user profiles to accepted CONTRACTOR personnel. User profiles will define levels of access into the system. The ENGINEER will determine assigned function-based authorizations and user privileges.
4. Give Subcontractors and Suppliers access to the EDMS. Be responsible for the entry of information exchanged and transferred on the EDMS between the CONTRACTOR and its Subcontractors and Suppliers.
5. Joint ownership of data: Data entered in a collaborative mode by the ENGINEER and the CONTRACTOR will be jointly owned.

B. Automated System Notification and Audit Log Tracking: Review comments made by the ENGINEER or CONTRACTOR-submitted documentation does not relieve the CONTRACTOR from compliance with the requirements of the Contract Documents. The CONTRACTOR is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. ENGINEER's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the CONTRACTOR's submitted information.

C. Utilization: Use the EDMS in connection with Submittal preparation and information management as specified in SECTION 01 31 00, SECTION 01 32 00, and SECTION 01 33 00.

D. Connectivity Problems: The EDMS is subject to the inherent speed and connectivity problems of the Internet. The CONTRACTOR is responsible for its own connectivity to the Internet. The EDMS response time is dependent on the CONTRACTOR's equipment, including processor speed, Internet access speed, and current traffic on the Internet. The ENGINEER is not responsible for any delays associated from the usage of the EDMS including, but not limited to, slow response time, down time periods, connectivity problems, or loss of information. Under no circumstances does usage of the EDMS constitute as grounds for a time extension or cost adjustment to the Contract.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for submittal procedures.

B. Related Sections:

1. SECTION 01 29 00 – PAYMENT PROCEDURES
2. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
3. SECTION 01 32 20 – ELECTRONIC DOCUMENT MANAGEMENT SYSTEM
4. SECTION 01 44 33 – MANUFACTURER'S SERVICES
5. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
6. SECTION 01 91 00 (.01 or .02) – COMMISSIONING

1.2 COORDINATION

A. Submittal Procedures:

1. Direct inquiries to the ENGINEER regarding procedure, purpose, or the extent of the Submittal.
2. Review the Submittal for compliance with the Contract Documents prior to Submittal.
3. Unless approved in advance by the OWNER, Submittals shall only contain requirements under one Specification Section.
4. Schedule and make submissions as specified in individual Specification Sections and in such a sequence as to cause no delay in the Work or in the Work of other Contractors.
5. Identification of Submittals:
   a. Identify each Submittal using the numbering and naming convention established and approved by the OWNER.
   b. Format Submittals in an orderly manner.
   c. Submittals shall be created and submitted electronically as specified in SECTION 01 32 20 and in accordance with the approved Enterprise Content Management Plan. Submittals shall be originally created, searchable PDF with bookmarks. Submittals not in this format will not be reviewed and will be returned to the CONTRACTOR. Supply hardcopies of Submittals and Shop Drawings upon the request of the OWNER. These requests are generally limited to the electrical and structural Shop Drawings; two hardcopies of each shall be supplied upon request.
   d. Submittal content organization and requirements:
      1) Show the date of submission.
      2) Show the Project title and the OWNER's Contract identification and Contract number.
      3) Show the names of the CONTRACTOR, the Subcontractor, or the Supplier, and the Manufacturer, as appropriate.
      4) Identify the Contract Documents section and the paragraph to which the Submittal applies.
      5) Identify the Submittal type; submit only one type in each Submittal package.
      6) Identify each deviation or variation from the Contract Documents.
6. Revise and resubmit the Submittal in its entirety when required; identify the changes made since the previous Submittal. When requested, submit additional information.
7. Submissions that are not required in the Contract Documents will be returned to the CONTRACTOR without review. Provide the reason for non-Contract Submittal if needed to complete the Work, for the ENGINEER's consideration.
8. Review times, completeness, and resubmittals:
   a. For each Submittal, allow 20 working days from time of delivery for the ENGINEER's review unless otherwise specified in the individual Specification Sections.
   b. For RFIs, allow 10 working days from time of delivery for the ENGINEER's review
   c. If Drawings, product Submittals, samples, mockups or other required submissions are incomplete or are not properly submitted, the ENGINEER will not review the Submittal and will immediately return the Submittal to the CONTRACTOR. Returned incomplete or improper Submittals count as one review.
   d. Complete resubmittals in the same review period as designated for the original Submittal. Make a complete and acceptable Submittal by the second submission of a Submittal item. The CONTRACTOR will be charged $500 per resubmittal for any returned Submittal with the "For Correction and Resubmittal" or "Rejected – Resubmit" disposition to cover additional ENGINEER time, costs, and delay for any review beyond the second Submittal. The amount of $500 (in a check from the CONTRACTOR made payable to Denver Water) shall be submitted with the third Submittal, and with each subsequent resubmittal, or the resubmittal will be returned to the CONTRACTOR without review. Coordinate the Submittal of related items.
9. Schedule delays:
   a. The adjustment of Contract Times or Contract Price due to the ENGINEER's review of Submittals will only be allowed if the following criteria are met:
      1) The CONTRACTOR notified the ENGINEER, in writing, that the timely review of the Submittal in question is critical to the progress of Work and has received the ENGINEER's written acceptance to reflect such. Written agreement by the ENGINEER to reduce the Submittal review time will be made only for unusual and CONTRACTOR-justified reasons. Acceptance of a CLS containing Submittal review times less than specified or less than agreed to, in writing, by the ENGINEER will not constitute the ENGINEER's acceptance of review times.

2) The ENGINEER failed to review and return the first submission of the Submittal within the agreed time shown on the current approved schedule of submissions; or, if no time is shown thereon, within 20 days after receipt.
3) The approved CLS has detailed the specific Submittal on the critical path, and the CONTRACTOR demonstrates the delay in the progress of the Work is directly attributable to the ENGINEER's failure to return the Submittal within the time shown and approved by the ENGINEER.

b. No adjustment of the Contract Times or Contract Price will be allowed due to delays in progress of the Work caused by rejection and subsequent resubmission of Submittals, including multiple resubmissions due to the fault or negligence of the CONTRACTOR.

B. Submittal Schedule:

1. Master submittal list: Submit an Excel spreadsheet into the EDMS within 20 working days of the Notice of Award, and a minimum of 5 working days prior to submitting any other Submittals. At the sole discretion of the OWNER, a Submittal may be accepted for review prior to receipt of the master submittal list. Include the schedule of Submittals, including duration of Submittal preparation, Submittal dates, and two OWNER review periods as prerequisites to procurement as part of the CLS as specified in SECTION 01 32 16 (.01 or .02). Master submittal lists shall include the following information for each anticipated Submittal, at a minimum:
   a. Name.
   b. Number/designation.
   c. Submittal date.
   d. Indication of priority, including denoting any critical, high-priority items.
   e. Reference Specification and subsection.
   f. Indication of intent to combine Submittals within a single Specification Section, if applicable.
2. Product Data: Submit product catalog data and the Manufacturer's instructions as PDF attachments to the Submittal form. Examples of product data include, but are not limited to, the following:
   a. Manufacturer's printed literature.
   b. Pre-printed product specification data and installation instructions.
3. Shop Drawings: Submit Shop Drawing and design data documents as PDF attachments to the Submittal form. Examples of Shop Drawings include, but are not limited to, the following:
   a. Standard Manufacturer installation Drawings.
   b. Drawings prepared to illustrate portions of the Work designed or developed by the CONTRACTOR.
   c. Standard warranty shall be submitted at the time of Shop Drawing Submittal.
   d. Steel fabrication, piece, and erection Drawings.
4. Samples: Submit samples as specified in this Section. Enter Submittal data information into the EDMS with a copy of the Submittal form attached to the sample. Examples of samples include, but are not limited to, the following:
   a. Product finishes and color selection.
   b. Product finishes and color verification.
   c. Finish/color boards.
   d. Physical materials.
5. Administrative Submittals: Transmit pre-construction Submittals using the EDMS. Examples of administrative Submittals include, but are not limited to, the following:
   a. Digging permits and notices for excavation.
   b. List of product substitutions.
   c. List of contact personnel.
   d. Notices for roadway interruption, Work outside regular hours, and utility cutovers.
   e. RFIs.
   f. Plans for safety, demolition, environmental protection, and similar activities.
   g. QC plan(s), testing plan and log, quality control reports, production reports, quality control specialist reports, preparatory phase checklist, initial phase checklist, field test reports, summary reports, rework items list, etc.
6. Correspondence: Submit official contract-related correspondence using the mail and transmittal functions of the EDMS. Examples of correspondence include, but are not limited to, the following:
   a. Meeting minutes.
   b. Record Drawings.
   c. General correspondence.
7. Compliance Submittals: Submit test reports, certificates, and Manufacturer's field report Submittals on the EDMS as PDF attachments. Examples of compliance Submittals include, but are not limited to, the following:
   a. Field test reports.
   b. Quality control certifications.
   c. Manufacturer's documentation and certifications for quality of products and materials provided.
8. Financial Submittals: Transmit financial Submittals on the EDMS. Examples of financial Submittals include, but are not limited to, the following:
   a. The CONTRACTOR's CLS.
   b. The CONTRACTOR's monthly Application for Payment.
   c. Contract change proposals requested by the OWNER.
9. Substantial Completion Submittals: Submit the following prior to Substantial Completion in accordance with the Agreement, General Conditions, the approved Enterprise Content Management Plan, and as specified in individual Specification Sections:

a. Correspondence.
b. Record Documents.
c. Approved Shop Drawings.
d. RFI, including final disposition and any supporting documents.
e. Final permits (occupancy, other).
f. O&M data and final equipment O&M manuals.
g. Commissioning, startup, and testing documentation.
h. Dated warranties, bonds, and service agreements.
i. Spare parts and special tools.

10. Contract Closeout Submittals: Submit the following prior to requesting Final Completion of the entire Work:
    a. Consent of surety to final payment.
    b. Releases or waivers of liens and claims.
    c. Releases from Agreements.
    d. Insurance policies.
    e. Final Application for Payment.

C. Disposition:
1. The ENGINEER will review, mark, and provide disposition as follows:
    a. Final for Construction (for incorporation in Work): Begin to implement activities to incorporate specific products or Work covered by the Submittal.
    b. Final for Construction, as Corrected (for incorporation in the Work): Begin to implement activities to incorporate products or Work covered by the Submittal, in accordance with notations.
    c. For Correction and Resubmittal: Submittal is not approved. Make corrections or develop a replacement and resubmit in the same manner specified for the original submission.
    d. Rejected – Resubmit: Submittal is not approved. Complete and resubmit.
    e. Accepted for Information: Submittal has been accepted for information, not reviewed.
2. Any required resubmittals shall include the content in the original Submittal to accommodate future archival. Incomplete or partial resubmittals will be rejected.

1.3 SUBMITTALS

A. Product Data:
1. Clearly mark (electronically in PDF) each Submittal to identify proposed products or models and show performance characteristics and capacities, the dimensions and clearances required, wiring or piping diagrams and controls, and external connections, anchorages, and supports required. If multiple products or models are shown, strike through items that are not proposed.
2. Supplement the Manufacturer’s standard data to provide information unique to the Work.

B. Shop Drawings:
1. Submit Shop Drawings and samples to the ENGINEER as specified in individual Specification Sections.
2. Present in a clear and thorough manner and in sufficient detail to show the kind, size, arrangement, and function of components, materials, and devices and compliance with the Contract Documents.
3. Identify:
    a. Pertinent drawing sheets and detail numbers, products, units and assemblies, and system or equipment identification or tag numbers.
    b. Critical field dimensions and relationships to other critical features of the Work.
    c. Each deviation or variation from the Contract Documents.
    d. Piping systems: Drawn to scale.
    e. Equipment and component titles: Identical to the title shown on the Drawings.
    f. Manufacturer's standard schematic drawings and diagrams:
        1) Delete information that is not applicable to the Work.
        2) Supplement standard information to provide information specifically applicable to the Work.
4. Design data: Show calculations, dimensions, assumptions, referenced standards, and codes upon which the design is based.
5. Provide dimensions in English units.
6. Reduce drawings and diagrams to 11 inches by 17 inches, if possible, unless otherwise specified or required for proper dimensioning.
7. Markups of original content shall be made in a PDF software capable of markup and editing.
8. Delete items or options not provided in the supplied equipment or system.
9. Foreign Manufacturers:
    a. The names and addresses of at least two companies closest to the Work that maintain technical service representatives.
    b. A complete inventory of spare parts and accessories for each piece of equipment.

C. Samples:
1. Submit samples to the ENGINEER as specified in individual Specification Sections. Create an electronic submission for Submittals, but also provide a physical sample to the ENGINEER with the transmittal sheet attached with the relevant Submittal information for reference.
2. Present in a clear and thorough manner and in sufficient detail to show the kind, size, arrangement, and function of components, materials, and devices, and compliance with the Contract Documents.
3. Samples: Submit samples as specified in individual Specification Sections.

4. Identify:
    a. Pertinent drawing sheets and detail numbers, products, units and assemblies, and system or equipment identification or tag numbers.
    b. Critical field dimensions and relationships to other critical features of the Work.
    c. Samples: Source, location, date taken, and by whom.
    d. Each deviation or variation from the Contract Documents.
    e. Piping systems: Drawn to scale.
    f. Equipment and component titles: Identical to the title shown on the Drawings.
    g. Manufacturer's standard schematic drawings and diagrams:
        1) Delete information that is not applicable to the Work.
        2) Supplement standard information to provide information specifically applicable to the Work.
5. Design data: Show calculations, dimensions, assumptions, referenced standards, and codes upon which the design is based.
6. Foreign Manufacturers:
    a. The names and addresses of at least two companies closest to the Work that maintain technical service representatives.
    b. A complete inventory of spare parts and accessories for each piece of equipment.

D. Administrative Submittals:
1. Submittals that are not Shop Drawings, samples, or product data and do not reflect the quality of product or the method of construction.
2. Progress reports and quantity charts: In accordance with the Contract Documents and as specified in SECTION 01 32 00.
3. Schedules: CLS, as specified in SECTION 01 29 00 and SECTION 01 32 16 (.01 or .02).
4. Training materials: As specified in SECTION 01 44 33.
5. Provide a site-specific EHSP including requirements specified in the Contract Documents.
    a. If Work involves working on or around chlorine or ammonia systems, include within the EHSP-specific training for working on or around chlorine and ammonia systems and a plan for reporting and documenting the training of current employees, future employees, Subcontractor employees, and any other persons performing Work on the Project in accordance with ARTICLES 4, 6, and 17 of the General Conditions and DIVISION 1 of the Specifications.
6. Provide documentation verifying the appropriate training of workers including employees of the CONTRACTOR, the Subcontractors, and the Suppliers performing Work on-site in accordance with the Contract Documents.
7. Provide Submittals required by laws, regulations, and governing agencies:
    a. Promptly submit notifications, reports, certifications, payrolls, and other items as required, directly to the applicable federal, state, or local governing agency or agency representative.
    b. Transmit to the ENGINEER, for the OWNER’s records: One copy of the correspondence and transmittals including enclosures and attachments between the CONTRACTOR and the governing agency. Do not include any correspondence or transmittals between the CONTRACTOR and the CONTRACTOR’s employees that are sensitive or confidential.

E. Spare Parts Submittals:
1. Provide a list of the Manufacturer’s recommended spare parts required for startup at the time of bid.
2. The Supplier shall provide an informational Submittal for each recommended spare in the format supplied by the CONTRACTOR as an electronic Excel file. Spare parts Submittal shall be submitted to the ENGINEER concurrent with the O&M data Submittal. Information for each spare part shall include the following:
    a. Manufacturer.
    b. Part number.
    c. Description.
    d. Recommended quantity.
    e. Unit cost in current US dollars.
    f. Dimensions.
    g. Weight in pounds.
    h. Shelf life in years.
    i. Delivery time to site in days.
    j. Whether or not the part is required for startup.
3. If the complete list of information is not provided, the Submittal will be considered incomplete and rejected by the ENGINEER. If any of the information is not applicable to the spare part or unavailable, clearly indicate on the Submittal to avoid Submittal rejection.

F. Quality Control Submittals:
1. Certificates:
    a. Manufacturer's certificate of compliance:
        1) Submit prior to the shipment of the product or material to the Work site.
        2) Ensure the certificate is signed by the Product Manufacturer certifying the materials, manufacture, and product conforms to or exceeds specified requirements and is appropriate for the intended use.
        3) Submit supporting reference data, test results, affidavits, and certifications, as appropriate.
    b. Certificates of successful testing or inspection: Submit when testing or inspection is required by laws and regulations, governing agencies, or specified in individual Specification Sections.

c. Manufacturer's certificate of proper installation: As specified in SECTION 01 44 33 and SECTION 01 91 00.

2. O&M manual: As specified in SECTION 01 78 23.
3. Statements of qualification: Provide evidence of qualification, certification, or registration in accordance with the Contract Documents.
4. Field samples: Provide as specified in individual Specification Sections.
5. Written test and inspection reports that include:
   a. Additional testing and reporting requirements as specified in SECTION 01 91 00 and individual Specification Sections.
   b. The date of the test and the date issued, the Project title and number, testing laboratory name, address, and telephone number, and the name and signature of the laboratory inspector.
   c. The date and time of the sampling or inspection and the record of the temperature and weather conditions.
   d. Identification of product and Specification Section, location of the sample, test, or inspection in the Work, the type of inspection or test with the referenced standard or code, and the certified results of the test.
   e. Compliance with the Contract Documents or the identification of corrective action necessary to bring materials and equipment into compliance.
   f. Provide an interpretation of the test results when requested by the ENGINEER.

G. Resubmittals: Resubmittals shall contain information relevant to the Submittal. The final revision of the Submittal shall be a complete package and shall be the record copy of the Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 35 43.19
ENVIRONMENTAL PROCEDURE – AQUATIC NUISANCE SPECIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for environmental procedure – aquatic nuisance species.

1.2 REFERENCES

A. State of Colorado, Department of Natural Resources: http://cpw.state.co.us/aboutus/Pages/ISP-Resources.aspx
   1. ANS Watercraft Inspection Handbook:
      a. ANS Documentation and Vessel Decontamination Form
      b. High Risk ANS Inspection Form

1.3 DEFINITIONS

A. ANS Inspector: An Inspector certified to perform ANS inspection by the Colorado Division of Wildlife or Colorado State Parks.

B. DW Waters: Any lake, reservoir, or body of water controlled by the OWNER.

1.4 SUBMITTALS

A. Submit prior to beginning Work:
   1. Qualifications of ANS Inspector and a copy of the Inspector's ANS card.
   2. Vessel, watercraft, and equipment entering DW waters.
   3. ANS procedures and forms to be used on Work.
   4. ANS Inspector completed ANS forms.

1.5 SITE CONDITIONS

A. The OWNER requires ANS inspections and decontamination procedures for vessels, watercraft, or equipment entering DW waters.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Vessels, watercraft, and equipment used in the Work shall not have been in any water body within the 30 days prior to use on this Work.

B. Provide an ANS Inspector to perform the following duties:
   1. Perform a high risk ANS inspection on vessels, watercraft, and equipment required to enter DW waters in accordance with the ANS Watercraft Inspection Handbook.
   2. Verify decontamination procedures and complete the ANS Documentation and Vessel Decontamination Form for any vessel, watercraft, or equipment if decontamination is found to be necessary.

C. Provide decontamination for any vessel, watercraft, or equipment, if required by the ANS Inspector, in accordance with the ANS Watercraft Inspection Handbook.

D. Provide required documentation to the ENGINEER prior to any vessel, watercraft, or equipment entering DW waters.

3.2 QUALITY CONTROL

A. ANS inspections in accordance with ANS Watercraft Inspection Handbook requirements.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 35 53
SECURITY PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for security procedures.

B. Related Sections:

1. SECTION 01 14 13 – ACCESS TO SECURE SITES

1.2 COORDINATION

A. Lockout/Tagout:

1. The OWNER operates under a strict lockout/tagout program. Where applicable to contract work safety, lockout sensitive equipment, switches, and instruments with a keyed lock and tag with the following information:
   a. Name and date of the lockout.
   b. Reason for the lockout.
   c. A contact phone number.
2. The OWNER may also lockout these components with a separate lock with similar information. Locks may only be removed by the person who installed them.
3. Lockout requirements include, but are not limited to, hatches, valves and other sources of hazardous energy developed from energy sources such as steam, water, natural gas, compressed air, chemicals, electricity, hydraulics, mechanical, or other energies.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Provide a lockable storage container for tools that will be stored on-site.

B. The OWNER is not responsible for lost or stolen tools.

1.4 SITE CONDITIONS

A. Facility Security:

1. Follow the additional requirements for site access as applicable to the site where Work is to be performed.
2. For restricted sites, as specified in SECTION 01 14 13.
3. Close and lock entrances to the facility to prevent the entry of unauthorized personnel.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Provide locks, tags, and personnel to perform lockout/tagout as necessary to perform the Work. Assist the OWNER in lockout/tagout requirements and execution.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information and execution for quality requirements.
- B. Related Sections:
  1. SECTION 01 45 00 – QUALITY CONTROL

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. E 329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

1.3 COORDINATION
- A. Carefully review the Contract Documents and report to the ENGINEER any error, omission, conflict, inconsistency, or code violation discovered.
- B. Require Subcontractors to comply with the requirements of the Contract Documents.
- C. Obtain written instructions from the ENGINEER prior to correcting identified conflicts or problems.
- D. Coordinate the sequence of activities to accommodate required QA/QC services with a minimum of delay and to avoid the necessity of removing and replacing construction to accommodate testing and inspection.
- E. Schedule times for tests, inspections, obtaining samples, and similar activities.
- F. Accommodate and ensure access for the OWNER and third-party inspections and testing activities.
- G. Work with the ENGINEER to ensure QA/QC activities are coordinated and complement one another.
- H. Ensure Project team members are following the QC plan.
- I. Enforce the quality requirements with the Subcontractors and remedy individual deficiencies and trends in quality that require correction. When necessary to correct quality issues, require the Subcontractors to replace personnel. When personnel replacement does not correct quality issues, work with the OWNER to mitigate, up to and including replacing the Subcontractor.
- J. Cooperate with agencies performing required tests, inspections, and similar QA/QC services, and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of the Work to permit assignment of personnel. Provide the following:
  1. Incidental labor and facilities necessary to accommodate tests and inspections, including facilities for storage and field curing of test samples.
  2. Adequate quantities of representative samples of materials that require testing and inspection. Assist in obtaining samples.
  3. Safe access to the site of test or inspection.

1.4 QUALITY ASSURANCE
- A. Applicable Codes:
  1. Structural: IBC.
  2. Mechanical:
     a. IMC.
     b. IPC.
  3. Electrical: NEC.
  4. Fire Protection: NFPA.
- B. Workmanship:
  1. Perform Work to the highest level of workmanship and detail possible.
  2. Meticulous work and high attention to detail regarding mechanical components, measurements, assembly, and other activities covered by the Contract Documents is expected.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL
- A. Responsibilities of the CONTRACTOR:
  1. Implement and conduct a QC program that ensures the timely and cost-effective completion of the Work in accordance with the Contract Documents and as specified in SECTION 01 45 00.
  2. Cooperate with the OWNER in accommodating OWNER-furnished material, furnishings, and equipment, its installation, and the OWNER's construction review.
  3. Attend meetings.
  4. Utilize sequentially numbered and dated forms to document requests for information and clarification.
  5. Provide and maintain a competent staff of experienced construction, administrative, and supervisory personnel in numbers sufficient to meet the Final Completion date.
  6. Provide and designate a competent, experienced person to perform QC reviews of Work.
  7. Responsibilities of the QC Reviewer:
     a. Review Work by the CONTRACTOR.
     b. Verify Work is ready for the ENGINEER's review.
     c. Schedule reviews with the ENGINEER.
     d. Be responsible in conjunction with the CONTRACTOR's Superintendent for the correction of non-conforming Work.
  8. If the CONTRACTOR fails to provide a competent and experienced person to perform QC reviews, the OWNER will retain the services of required staff and deduct their fees from the progress payments due to the CONTRACTOR.

9. Provide a detailed time schedule of operations for Work. Monitor the schedule as Work progresses and revise the schedule at appropriate intervals, or as requested by the ENGINEER, to reflect actual progress.

B. Special Inspections and Testing:
   1. Special inspections and testing required by the building permit will be performed by the OWNER, or a third-party consultant hired by the OWNER, at the OWNER's expense. Further information on special inspections and testing is specified in the applicable building codes, individual Specification Sections, and the Drawings.
   2. Schedule applicable special inspections and notify the ENGINEER 7 days in advance for the required special inspections. Account for the necessary time to complete special inspections in the Work; compensation will not be given for any delays or costs associated with them.
   3. Code-required special inspection with associated testing as specified in the Statement of Special Inspections shown on the Drawings, is for the benefit of the OWNER.
      a. It does not relieve the CONTRACTOR of responsibility to provide adequate QC measures.
      b. It does not relieve the CONTRACTOR of responsibility for damage to or loss of material before acceptance.
      c. It does not constitute or imply acceptance.
      d. It does not affect continuing rights of the OWNER after acceptance of completed Work.
   4. The CONTRACTOR is responsible for additional costs associated with special inspection and testing and observation, when the Work is not ready at the time identified by the CONTRACTOR and special inspectors or professional observers are on-site, but not able to provide contracted services, and by special inspectors and professional observers required because of rejection of materials or in-place Work that cannot be made compliant to the Contract Documents without additional inspections and observation and testing.

END OF SECTION

SECTION 01 41 01
REGULATORY REQUIREMENTS AT TREATMENT PLANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for regulatory requirements at treatment plants.

1.2 REFERENCES

A. Environmental Protection Agency's (EPA):
   1. 40 CFR Part 68 – Chemical Accidental Prevention Provisions

1.3 SUBMITTALS

A. Submit prior to beginning the Work:
   1. The CONTRACTOR's comprehensive EHSP.
   2. The CONTRACTOR's Project safety-specific flow chart.
   3. The completed Training Record (Supplement A); the training record shall be updated and resubmitted as new employees access the site.

B. Supplements listed in this Section.

1.4 SITE CONDITIONS

A. Attend a safety briefing and be responsible for training employees working in the Work site. The Contract Documents will identify the types of chemical hazards that may be present in the Work.

B. The OWNER is regulated by the EPA's 40 CFR Part 68.

C. This regulation pertains to the disclosure and safety requirements associated with chemical systems maintained and operated by the OWNER at the treatment plant.

D. Follow the EPA's 40 CFR Part 68 regulatory compliance requirements.

E. Attend an OWNER's training session on chemical and safety training awareness prior to working at the treatment plant.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Develop a Project specific flow chart identifying Work activities, potential hazards, and safety measures to be utilized.

B. Provide a qualified Safety Instructor in potential fire, explosion, and toxic release hazards to perform the following duties:
   1. Ensure and document to the OWNER that the employees of the CONTRACTOR or Subcontractors working at the site have completed and understood instruction related to their job and process and applicable provisions of the emergency action plan of the OWNER.
   2. Complete Supplement A and deliver it to the OWNER verifying training for employees working on-site, including the name, employee identification, date of training, signature of the Qualified Safety Instructor, and the signature of the person receiving instruction.
   3. The OWNER will provide a hardcopy of the training program to the CONTRACTOR for use during the Work. This copy shall not be reproduced, shall remain at the Work site, and shall be returned to the OWNER by the Substantial Completion date of the Work.
   4. Verify that persons working on-site are following the safety rules for working on or around potential fire, explosion, or toxic release hazards including the safe working practices required by EPA's 40 CFR Part 68.
   5. Make regular reports to the ENGINEER that on-site personnel are in compliance.
   6. Ensure workers follow the requirement that the OWNER shall be present and assisting any persons for entry, while present in and when exiting restricted, locked areas as identified in the OWNER's training session.

3.2 SUPPLEMENTS

A. Supplement A is part of the DW plant RMP and is included to disclose to the CONTRACTOR that documentation of employee training will be required:
   1. Supplement A – Potential Explosion or Toxic Release Hazards Training Record

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A Potential Explosion or Toxic Release Hazards Training Record				
Employee Name	**Employee ID**	**Training Date**	**Trainer Signature**	**Employee Signature**
Trainer and Employee: By signing you are attesting under penalty of law that the employee has completed and understood the required training in potential fire, explosion, and toxic hazards.				

INTENTIONALLY BLANK

SECTION 01 41 26
PERMITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for permits.

B. Related Sections:

1. SECTION 01 33 00 – SUBMITTAL PROCEDURES

1.2 COORDINATION

A. Obtain permits required for the execution of the Work, in accordance with the Contract Documents. Furnish copies of all executed permits obtained by CONTRACTOR to the ENGINEER as specified in SECTION 01 33 00

B. Materials submitted to the ENGINEER includes, but is not limited to, completed application materials, the permit, written correspondence between the CONTRACTOR and the Regulatory Agency issuing the permit and any information required to be submitted to demonstrate compliance with permit terms and conditions (e.g. inspection reports).

C. Any fees listed in this Section are estimates and for CONTRACTOR's information only. Verify and pay actual fees.

D. Completeness of the list is not guaranteed by the OWNER. The absence of information does not relieve CONTRACTOR of responsibility for determining and verifying the extent of permits required and of obtaining permits.

E. Confirm lead and review time frames associated with permit submittal and approval. Incorporate all permit requirements, permit lead times, submittal review periods and resubmittals into CONTRACTOR's CPM schedule.

F. If there are requirements made in other specification sections that conflict with requirements of permits, the requirements set forth in the permits shall take precedence.

G. Summary of permits to be obtained by the CONTRACTOR:

1. Coordinate permit applications and Submittals directly with the ENGINEER and the OWNER's Permit Coordinator. Complete permit application processes in person at each jurisdiction's permit center for those required permits.
2. For building permits, refer to the requirements of the City. Comply with all agency requirements.

H. Summary of permits to be obtained by the OWNER:

1. Unless the location is otherwise specifically indicated, permits apply to the entire site. Satisfy the conditions of all permits.
2. No additional compensation or additional Contract Times will be granted to CONTRACTOR because of delays by OWNER in obtaining any permit unless CONTRACTOR is unable to proceed and complete Work and such delays are clearly demonstrated by the CONTRACTOR's progress schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for abbreviations and acronyms.

1.2 REFERENCES

A. Refer to Paragraph 3.3 of the General Conditions, requirements of this Section, and individual Specification Sections to interpret references to the standards and specifications of technical societies and the use of these references to report and resolve discrepancies.

B. Work specified by reference to a published standard or specification shall meet or surpass the minimum standards of quality for materials and workmanship established by the designated standard or specification.

C. Products and workmanship shall meet or exceed performance requirements included within the Contract Documents, which may establish a higher standard of quality than that required by a referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed the requirements of the most stringent standard.

E. Copies of Standards and Specifications of Technical Societies:

1. Copies of applicable referenced standards are not included in the Contract Documents.
2. When copies of standards are needed, obtain copies directly from the publication source and maintain in an orderly manner at the site; make the standards available to the CONTRACTOR's personnel, Subcontractors, the OWNER, and the ENGINEER.
3. Use the latest edition of references.

F. Technical Societies:

1.	AA	The Aluminum Association
2.	AAMA	American Architectural Manufacturers Association
3.	AAR	Association of American Railroads
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ACI	American Concrete Institute
6.	ADC	Air Diffusion Council
7.	AEIC	Association of Edison Illuminating Companies
8.	AISC	American Institute of Steel Construction
9.	AISI	American Iron and Steel Institute
10.	AMCA	Air Movement and Control Association International
11.	ANSI	American National Standards Institute
12.	AOSA	Association of Official Seed Analysts
13.	APA	APA – The Engineered Wood Association
14.	API	American Petroleum Institute
15.	ASCE	American Society of Civil Engineers
16.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
17.	ASME	American Society of Mechanical Engineers
18.	ASNT	American Society for Nondestructive Testing
19.	ASTM	ASTM International
20.	AWI	Architectural Woodwork Institute
21.	AWPA	American Wood Preservers Association; American Wood Protection Association
22.	AWS	American Welding Society
23.	AWWA	American Water Works Association
24.	BHMA	Builders Hardware Manufacturers Association
25.	BIA	Brick Industry Association
26.	CAN/ULC	Underwriters Laboratories of Canada
27.	CBEMA	Computer and Business Equipment Manufacturers Association
28.	CBMA	Certified Ballast Manufacturers Association
29.	CDOT	Colorado Department of Transportation
30.	CDPHE	Colorado Department of Public Health and Environment
31.	CFR	Code of Federal Regulations
32.	CI	The Chlorine Institute
33.	CISCA	Ceiling and Interior Systems Construction Association
34.	CPPM	Capital Projects Procedures Manual
35.	CPSC	U.S. Consumer Product Safety Commission
36.	CRSI	Concrete Reinforcing Steel Institute
37.	CSA	CSA Group
38.	CWQCD	Colorado Water Quality Control Division
39.	DIA	Denver International Airport
40.	DOT	Department of Transportation
41.	DW	Denver Water
42.	EPA	Environmental Protection Agency
43.	FCC	Federal Communications Commission
44.	FHWA	Federal Highway Administration
45.	FMG	FM Global

46.	FS	Federal Specifications
47.	FSC	Forest Stewardship Council
48.	GA	Gypsum Association
49.	G.E.	General Electric
50.	GSA	General Services Administration
51.	IAPMO-UES	International Association of Plumbing and Mechanical Officials – Uniform Evaluation Service
52.	IBC	International Building Code
53.	ICC-ES	International Code Council Evaluation Service, Inc.
54.	ICEA	Insulated Cable Engineers Association
55.	ICRI	International Concrete Repair Institute
56.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
57.	IES	Illuminating Engineering Society of North America
58.	IGMA	Insulating Glass Manufacturers Alliance
59.	IMC	International Mechanical Code
60.	IPC	International Plumbing Code
61.	ISA	International Society of Automation
62.	ISO	International Organization for Standardization
63.	MHFD	Mile High Flood District
64.	Mil. Spec.	Military Specification
65.	MSS	Manufacturers Standardization Society
66.	NAAMM	National Association of Architectural Metal Manufacturers
67.	NACE	NACE International
68.	NAFS	North American Fenestration Standard
69.	NCMA	National Concrete Masonry Association
70.	NEC	National Electrical Code
71.	NECA	National Electrical Contractors Association
72.	NEMA	National Electrical Manufacturers Association
73.	NETA	InterNational Electrical Testing Association
74.	NFPA	National Fire Protection Association
75.	NGA	National Glass Association with GANA
76.	NICET	National Institute for Certification of Engineering Technologies
77.	NIST	National Institute of Standards and Technology
78.	NF	Française de Normalisation
79.	NLGA	National Lumber Grades Authority
80.	NOAA	National Oceanic and Atmospheric Administration
81.	NPCA	National Precast Concrete Association
82.	NPDES	National Pollutant Discharge Elimination System
83.	NRCA	National Roofing Contractors Association
84.	NRCS	National Resource Conservation Service
85.	NRTL	Nationally Recognized Testing Laboratory
86.	NSF	NSF International
87.	OSHA	Occupational Safety and Health Administration
88.	PCI	Precast/Prestressed Concrete Institute
89.	RILEM	International Union of Laboratories and Experts in Construction Materials, Systems, and Structures
90.	RIS	Redwood Inspection Service
91.	SAE	SAE International
92.	SDI	Steel Deck Institute
93.	SJI	Steel Joist Institute
94.	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
95.	SPIB	Southern Pine Inspection Bureau
96.	SPRI	Single Ply Roofing Institute
97.	SSPC	The Society for Protective Coatings
98.	TCNA	Tile Council of North America
99.	TMS	The Masonry Society
100.	UBC	Uniform Building Code
101.	UL	Underwriters Laboratories, Inc.
102.	WCLIB	West Coast Lumber Inspection Bureau
103.	WDMA	Window and Door Manufacturers Association
104.	WQCD	Water Quality Control Division
105.	WWPA	Western Wood Products Association

G. General Abbreviations and Acronyms:

1.	°C	Degrees Celsius
2.	°F	Degrees Fahrenheit
3.	ABS	Acrylonitrile Butadiene Styrene
4.	AC	Alternating Current
5.	ACQ	Alkaline Copper Quaternary

6.	ADA	Americans with Disabilities Act
7.	ADC	Amperes Direct Current
8.	AHJ	Authority Having Jurisdiction
9.	AMI	Advanced Metering Infrastructure
10.	AMR	Automatic Meter Reading System; Automatic Reading System
11.	ANS	Aquatic Nuisance Species
12.	AO	Analog Output
13.	ARMS	Arc Flash Reduction Maintenance System
14.	AT	Acrylic-Tie
15.	ATS	Acceptance Testing Specifications; Automatic Transfer Breaker Switch
16.	AVR	Automatic Voltage Regulator
17.	AWG	American Wire Gauge
18.	B&B	Balled and Burlapped
19.	BBU	Beam Bolster Upper
20.	BF	Ballast Factor
21.	BFPA	Backflow Prevention Assembly
22.	BHN	Brinell Hardness Number
23.	BIL	Basic Impulse Insulation Level
24.	BSSTC	Bolted Split Sleeve Type Coupling
25.	BSTC	Bolted Sleeve Type Coupling
26.	Btu	British Thermal Unit
27.	BUR	Buried
28.	CAC	Ceiling Attenuation Class
29.	CAT	Category
30.	CBD	Complex Steel Building Structures
31.	CBR	Major Steel Bridges
32.	CCT	Correlated Color Temperature
33.	CCTV	Closed Circuit Television
34.	cf	Cubic Feet
35.	CFC	Chlorofluorocarbon
36.	cfm	Cubic Feet per Minute
37.	CI	Cast Iron
38.	CLCST	Cement-Lined Carbon Steel
39.	CLDI	Cement-Lined Ductile Iron
40.	CLS	Cost Loaded Schedule
41.	CLSM	Cementitious Low Strength Material; Controlled Low Strength Material
42.	cm	Centimeter
43.	CM/GC	Construction Manager/General Contractor
44.	CMAR	Construction Manager At Risk
45.	CML	Cement Mortar Lining
46.	CMU	Concrete Masonry Unit
47.	CNA	Colorado Nursery Act
48.	CO	Carbon Monoxide
49.	CP	Carrier Pipe; Cathodic Protection
50.	CPCS	Capital Projects Construction Standards
51.	CPE	Chlorinated Polyethylene
52.	CPM	Construction Project Manager; Critical Path Method
53.	cps	Centipoise
54.	CPU	Central Processing Unit
55.	CPVC	Chlorinated Polyvinyl Chloride
56.	CRF	Condensation Resistance Factor
57.	CSE	Copper/Copper Sulfate Reference Electrode
58.	CST-G	Carbon Steel – General Service
59.	CT	Current Transformer
60.	CTLA	Council of Tree and Landscape Appraisers
61.	CWP	Cold Working Pressure
62.	cy	Cubic Yard
63.	dB	Decibel
64.	DC	Direct Current; Double Check Valve
65.	DCP	Distribution Control Panel
66.	DFT	Dry Film Thickness
67.	DI	Ductile Iron
68.	DO	Dissolved Oxygen
69.	DPDT	Double Pole Double Throw
70.	dPF	Differential Pressure Filter
71.	DR	Dimensional Ratio
72.	dS	Decisiemens

73.	DSL	Digital Subscriber Line
74.	DW	Denver Water
75.	EASE	Electronically Activated Streamer Emission
76.	ECP	Environmental Control Panel
77.	EDMS	Electronic Document Management System
78.	EHH	Electrical Hand Hole
79.	EHSP	Environmental Health and Safety Program
80.	EI&C	Electrical, Instrumentation, and Control
81.	EMI	Electromagnetic Interference
82.	EMT	Electrical Metallic Conduit
83.	EPDM	Ethylene Propylene Diene Monomer
84.	EPO	Emergency Power Off
85.	EPR	Ethylene Propylene Rubber
86.	ER	Evaluation Report
87.	ERT	Encoder-Receiver-Transmitter
88.	ESA	Electrical Systems Analysis
89.	ESAL	Equivalent Single Axle Load
90.	ESD	Emergency Shut Down
91.	ESR	Evaluation Service Report
92.	EU	Electric Utility
93.	EUH	Electric Unit Heater
94.	EVT	Equiviscous Temperature
95.	EXP	Exposed
96.	fc	Foot-Candle
97.	FCR	Frequency Correction Regulator
98.	FDT	Factory Demonstration Test
99.	FLA	Full Load Ampere
100.	F'm	Compressive Strength of Masonry
101.	FOB	Freight on Board
102.	fpm	Feet per Minute
103.	fps	Feet per Second; Foot per Second
104.	FRP	Fiberglass Reinforced Plastic
105.	ft	Feet; Foot
106.	g	Grams
107.	GBR	Geotechnical Baseline Report
108.	GCP	Generator Control Panel
109.	GFCT	Ground Fault Current Transformer
110.	GICS	Generator Instrumentation and Control System
111.	GP	Poorly Graded Gravel
112.	gph	Gallons per Hour
113.	gpm	Gallons per Minute
114.	GPR	Ground Penetrating Radar
115.	GPS	Global Positioning System; Generator Protection System
116.	GTAW	Gas Tungsten Arc Welding
117.	GUI	Graphical User Interface
118.	GW	Well Graded Gravel
119.	HBP	Hot Bituminous Pavement
120.	HC	Hydrocarbon
121.	HCl	Hydrochloric Acid
122.	HDCLPE	High Density Cross Laminated Polyethylene Film
123.	HDD	Horizontal Directional Drilling
124.	HDG	Hot-Dipped Galvanized
125.	HDPE	High Density Polyethylene
126.	HID	High Intensity Discharge
127.	HMI	Human Machine Interface
128.	HMWPE	High Molecular Weight Polyethylene
129.	hp	Horsepower
130.	hr	Hour
131.	HR	Hydrophilic Rubber
132.	HVAC	Heating, Ventilating, and Air Conditioning
133.	Hz	Hertz
134.	I&C	Instrumentation and Controls
135.	I/O	Inputs and Outputs
136.	ICCP	Impressed Current Cathodic Protection
137.	ID	Identification; Inside Diameter
138.	IGBT	Insulated Gate Bipolar Transistors
139.	IP	Iron Pipe

140.	IPS	Iron Pipe Standard
141.	in	Inch
142.	IR	Current Resistance
143.	K	Kelvin
144.	kA	Kiloamperes
145.	KAIC	Kiloamperes Interrupting Capacity
146.	kg	Kilogram
147.	KHz	Kilohertz
148.	km	Kilometer
149.	kN	Kilonewtons
150.	ksi	Kips per Square Inch
151.	kV	Kilovolt
152.	kVA	Kilovolt-Amperes
153.	kVAR	Kilovolt-Amperes Reactive
154.	kW	Kilowatt
155.	L	Liter
156.	LA	Lightning Arrestor
157.	lbf	Pound-Force per Square Foot
158.	lbs	Pounds
159.	LCD	Liquid Crystal Display
160.	LCP	Local Control Panel
161.	LED	Light Emitting Diodes
162.	lf	Linear Feet; Linear Foot
163.	LFMC	Liquid-Tight Flexible Metal Conduit
164.	LLDPE	Linear Low Density Polyethylene
165.	LS	Low Level Switch
166.	LVDT	Linear Variable Differential Transformer
167.	m	Meter
168.	mA	Milliamperes
169.	MARV	Minimum Average Roll Value
170.	Mbps	Megabits per Second
171.	MCC	Motor Control Center
172.	MDFT	Minimum Dry Film Thickness
173.	MDFTPC	Minimum Dry Film Thickness per Coat
174.	MDI	Methylene Diphenyl Diisocyanate
175.	MERV	Minimum Efficiency Reporting Value
176.	MGS	Magnetic Guidance System
177.	MHz	Megahertz
178.	MIG	Metal Inert Gas
179.	mil	Thousandth of an inch
180.	MJ	Mechanical Joint
181.	MLDT	Magneto-Restrictive Linear Displacement Transmitter
182.	mm	Millimeter
183.	MNPT	Male National Pipe Thread
184.	MOC	Mechanism Operated Cell
185.	MOV	Metal Oxide Varistor
186.	MPR	Motor Protection Relay
187.	MS	Material Specification
188.	ms	millisecond
189.	MSA	Mine Safety Appliance
190.	MSDS	Material Safety Data Sheet
191.	MTBF	Mean Time Between Failure
192.	MTTR	Mean Time to Repair
193.	MUTCD	Manual on Uniform Traffic Control Devices
194.	mV	Millivolt
195.	MVA	Megavolt Amperes
196.	N	Nitrogen
197.	NA	Numerical Aperture
198.	NC	Normally Closed
199.	NCR	Non-Conformance Report
200.	NHT	National Hose Thread
201.	No.	Number
202.	NO	Normally Open
203.	NO_x	Nitrous Oxide
204.	NPT	National Pipe Thread
205.	NRC	Noise Reduction Coefficient
206.	ns	Nanosecond

207.	NST	National Standard Thread
208.	OBD	Opposed Blade Damper
209.	OD	Outside Diameter
210.	ODP	Open Drip-Proof Enclosure
211.	OEL	Over-Excitation Limiter
212.	O&M	Operations and Maintenance
213.	OCR	Optical Character Recognition
214.	OPM	Optical Processor Module
215.	OPS	Overcurrent Protection System
216.	ORT	Operational Readiness Test
217.	OTDR	Optical Time Domain Reflectometer
218.	oz	Ounce
219.	P_2O_5	Phosphate
220.	P&ID	Process and Instrumentation Diagram
221.	PA	Paint Application
222.	PAT	Performance Acceptance Test
223.	PAR	Parabolic Aluminized Reflector
224.	PCB	Polychlorinated Biphenyl
225.	PCC	Point of Common Coupling
226.	PCCS	Piping Color Code Schedule
227.	pcf	Pounds per Cubic Foot
228.	PDS	Product Data Sheets
229.	PE	Polyethylene
230.	PEI	Pulse Endurance Index
231.	perm-inch	permeability coefficient
232.	pF	Pico Farad
233.	PF	Power Factor
234.	PFCC	Power Factor Correction Capacitor
235.	PFM	Pulse Frequency Modulation
236.	pH	Measure of the acidity or basicity of an aqueous solution
237.	PI	Point of Intersection; Polarization Index
238.	PLC	Programmable Logic Controller
239.	PLS	Pure Live Seed
240.	PLSS	Public Land Survey System
241.	PMS	Pantone Matching System
242.	PP	Polypropylene
243.	PPDS	Paint Product Data Sheet
244.	ppm	Parts per Million
245.	PPT	Polypropylene Tubing
246.	PRE	Permanent Reference Electrode
247.	PRS	Pressure Regulating Stems
248.	PS	Pressure Switch
249.	PSDS	Paint System Data Sheet
250.	psf	Pounds per Square Foot
251.	psi	Pounds per Square Inch
252.	psig	Pounds per Square Inch Gauge
253.	PSW	Plastic Space Wheels
254.	PT	Potential Transformer
255.	PTFE	Polytetrafluoroethylene
256.	PTI	Propiconazole Tebuconazole Imidacloprid
257.	PU	Phone Utility
258.	PV	Process Variable
259.	PVB	Pressure Vacuum Breaker
260.	PVC	Polyvinyl Chloride
261.	PVC-T	Polyvinyl Chloride Tubing
262.	PVDF	Polyvinylidene Fluoride
263.	PWM	Pulse Width Modulation
264.	QA	Quality Assurance
265.	QC	Quality Control
266.	QA/QC	Quality Assurance and Quality Control
267.	QP	Qualification Procedure
268.	RAT	Reliability Acceptance Test
269.	RE	Reynolds Number; Removability Modulus
270.	RFI	Request for Information
271.	RGS	Rigid Galvanized Steel
272.	RMP	Risk Management Plan
273.	rms	Root Mean Square

274.	ROM	Read Only Memory
275.	ROW	Right of Way
276.	RP	Reduced Pressure Principle
277.	rpm	Revolutions Per Minute
278.	RPTFE	Reinforced Polytetrafluoroethylene
279.	RTD	Resistance Temperature Detector
280.	RTFE	Reinforced Tetrafluoroethylene
281.	RTU	Remote Terminal Unit
282.	S4S	Surfaced Four Sides
283.	SAD	Silicon Avalanche Diode
284.	SAL	Site Access Log
285.	SAM	Seal-A-Matic
286.	SBD	Conventional Steel Building Structures
287.	SBR	Styrene Butadiene Rubber
288.	SBS	Styrene Butadiene Styrene
289.	SCADA	Supervisory Control and Data Acquisition
290.	scfm	Standard Cubic Feet per Minute
291.	SDL	Site Delivery Log
292.	SDR	Standard Dimensional Ratio
293.	SDS	Safety Data Sheet
294.	SDT	Site Demonstration Test
295.	sf	Square Feet; Square Foot
296.	SF	Service Factor
297.	sfpg	Square Feet per Gallon
298.	sfpgpc	Square Feet per Gallon per Coat
299.	SM	Silty Sand
300.	SP	Surface Preparation; Poorly Graded Sand; Setpoint
301.	SPD	Surge Protective Device
302.	SPDT	Single-Pole, Double-Throw
303.	SPM	Synchronous Motor Protection and Control
304.	SPST	Single Pole Single Throw
305.	sq	Square
306.	SRW	Segmental Retaining Walls
307.	SSD	Saturated Surface Dry
308.	SSH	Safety Shower Eye/Face Wash
309.	SST	Stainless Steel
310.	STC	Sound Transmission Class
311.	SUB	Submerged
312.	SV	Setpoint Variable
313.	SW	Well graded sand
314.	SWMP	Stormwater Management Plan
315.	SWP	Safe Working Pressure
316.	sy	Square Yard
317.	T	Thickness
318.	TBD	To Be Determined
319.	TDD	Total Demand Distortion
320.	TEFC	Totally Enclosed, Fan Cooled Enclosure
321.	TENV	Totally Enclosed, Non-Ventilated Enclosure
322.	TFE	Tetrafluoroethylene (Teflon)
323.	TGIC	Triglycidyl Isocyanurate
324.	THD	Total Harmonic Distortion
325.	TOC	Truck Operated Cell
326.	TPE-R	Thermoplastic Elastomeric Rubber
327.	TPST	Triple Pole Single Throw
328.	TS	High Temperature Switch
329.	TSCA	Toxic Substances Control Act
330.	TVSS	Transient Voltage Surge Suppressors
331.	TX	Transformer
332.	UC2	Use Category 2
333.	UC3B	Use Category 3B
334.	UC4A	Use Category 4A
335.	UC4B	Use Category 4B
336.	UC4C	Use Category 4C
337.	UCFA	Use Category FA
338.	UCFB	Use Category FB
339.	UEL	Under-Excitation Limiter
340.	UFT	Unwitnessed Factory Test

341.	UPS	Uninterruptible Power Supply
342.	U.S.	United States
343.	UTA	Universal Termination Assemblies
344.	UV	Ultraviolet
345.	V	Volt
346.	VA	Volt Amperes
347.	VAC	Volts Alternating Current
348.	VDC	Volts Direct Current
349.	VFD	Variable Frequency Drive
350.	VLF	Very Low Frequency
351.	VOC	Volatile Organic Compound
352.	VPP	Volts Peak-to-Peak
353.	W	Watt
354.	WBS	Work Breakdown Structure
355.	WC	Water Column
356.	w/cm	Water/Cementitious Material Ratio
357.	WOG	Water-Oil-Gas
358.	WPI	Open Weather Protected Enclosure, Type I
359.	WPII	Open Weather Protected Enclosure, Type II
360.	WT shapes	Wide Flange Tee
361.	XLP	Crosslinked Polyethylene

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 00
QUALITY ASSURANCE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for quality assurance.

B. Related Sections:

1. SECTION 01 40 00 – QUALITY REQUIREMENTS
2. SECTION 01 45 00 – QUALITY CONTROL

1.2 DEFINITIONS

A. Quality Assurance:

1. A system of procedures for selecting the levels of quality required for a project or portion thereof in order to perform the functions intended, and for assuring these levels are obtained. The OWNER is responsible for establishing quality assurance.
2. Quality assurance is process-oriented. It focuses on the process of quality, a process that monitors the CONTRACTOR's QC plan to assure it is working.
3. Quality assurance includes administrative and procedural requirements for proactive activities to assure the quality of construction before and during execution of the Work.

1.3 COORDINATION

A. Accommodate and ensure access for OWNER inspections and testing activities.

B. Work with the ENGINEER to ensure quality assurance and quality control are coordinated and complement one another.

C. Ensure project team members are following the QC plan.

1.4 SUBMITTALS

A. Refer to individual Specification Sections for specific qualifications and requirements:

1. Manufacturer Qualifications.
2. Supplier Qualifications.
3. Fabricator Qualifications.
4. Installer Qualifications.
5. Testing and Inspecting Agency Qualifications.
6. Code-Required Special Inspector Qualifications.
7. Manufacturer's Field Services.
8. Field Samples.
9. Mockups.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 APPLICATION

A. Non-Conformance: The OWNER may issue a NCR to document and track an issue when the CONTRACTOR fails to correct an installation that does not meet the levels of quality required. Upon issuance, respond as detailed in the NCR, correct the item, and obtain approval for the correction. NCRs shall be closed with the necessary approvals before Final Completion will be granted.

1. Examples of non-conforming Work that may generate the NCR:
   a. Installation of unspecified or unapproved products.
   b. Work that does not comply with an applicable code.
   c. Equipment and materials that do not meet the requirements of the Contract Documents.
   d. Poor quality of workmanship, products, or equipment.
   e. Corrective Work that is not addressed in a timely manner.

B. For quality control requirements as specified in SECTION 01 40 00, SECTION 01 45 00, and the individual Specification Sections.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 44 33
MANUFACTURER'S SERVICES

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information and execution for Manufacturer's services.
- B. Related Sections:
  1. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA

1.2 DEFINITIONS
- A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.3 SUBMITTALS
- A. Preliminary Training Plan: Submit within 90 days after receiving the Notice to Proceed and in the format delineated in this Section.
- B. Training Schedule: Submit a minimum of 21 days prior to the start of equipment installation. The training schedule shall be listed as an activity in the CLS.
- C. Final Training Plan: Submit after the training coordination meeting.
- D. Training Materials:
  1. Submit written outlines of the proposed training sessions a minimum of 21 days prior to the scheduled training.
  2. Furnish complete training materials including O&M data.
- E. Quality Control Submittals:
  1. Qualifications of Manufacturer's Representative.
  2. Manufacturer's certificate of proper installation.
- F. Forms:
  1. The following forms can be found online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual:
     a. Manufacturer's Certificate of Proper Installation.
     b. Maintenance Summary.
     c. Equipment Startup Requirements.
     d. Equipment Testing Record.
     e. Construction Completion Sign-Off.
     f. Manufacturer's Instruction Certification.

1.4 QUALIFICATIONS
- A. Manufacturer's Representative:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. An authorized Representative of the Manufacturer, factory trained, and experienced in technical applications, installation, operation, and maintenance of the respective equipment, subsystem, or system.
  3. Obtain approval of the Manufacturer's Representative prior to beginning Work.
  4. Do not change the Manufacturer's Representative without the ENGINEER's approval.

1.5 QUALITY ASSURANCE
- A. Minimum Services:
  1. Furnish a qualified Manufacturer's Representative familiar with the facility O&M requirements and specified equipment.
  2. Schedule Manufacturer's services:
     a. To avoid conflicting with other on-site testing or other Manufacturer's on-site services.
     b. After conditions necessary to allow for successful testing have been met.
  3. Minimum Manufacturer's on-site services include:
     a. Assistance during product installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation, or application procedures.
     b. Inspection, checking, and adjustment as required for the product to function as warranted by the Manufacturer and as necessary to furnish written approval of the installation.
     c. Revisiting the site to correct problems until installation and operation are acceptable.
     d. Resolution of assembly or installation problems attributable to or associated with the Manufacturer's products and systems.
     e. Assistance during functional and performance testing and startup demonstration until product acceptance.
     f. Training of personnel in the O&M of respective products as specified in this Section.
     g. Completion of the Manufacturer's certificate of proper installation with applicable certificates for proper installation and initial, interim, and final test or service.
  4. Only ENGINEER-approved days of service will be credited to fulfill the specified minimum services.
  5. Where additional time is necessary for Manufacturer's services, additional time required to perform specified services shall be considered incidental Work.
- B. Training:
  1. Provide the CONTRACTOR's Training Representative:
     a. To coordinate and expedite training.
     b. To be present during training coordination meetings with the OWNER.
     c. To be familiar with the O&M manual information specified in SECTION 01 78 23.
  2. Provide the training schedule:
     a. List specified equipment and systems that require training and show:
        1) The name of the Manufacturer.

2) Estimated dates for installation and completion.
3) Estimated training dates to allow for multiple sessions when several shifts are involved.

b. Adjust the training schedule:
1) To ensure the training of appropriate personnel as deemed necessary.
2) To allow for full participation by the Manufacturer's Representatives.
3) For interruptions in the operation of equipment.

3. Provide a preliminary training plan to include:
a. Title and objectives.
b. Prerequisite training and experience of attendees.
c. Recommended types of attendees: Managers, engineers, operators, and maintenance.
d. Course description and an outline of course content.
e. Duration.
f. Location: Training center or on-site.
g. Format: Lecture, self-study, demonstration, or hands-on.
h. Instruction materials and equipment requirements.

4. Provide a final training plan to include:
a. Updated versions of course descriptions.
b. Course attendees.
c. A detailed course schedule for each day showing the time allocated to each topic.
d. Resumes of the instructors providing the training.

5. Responsibilities of the Manufacturer's Representative:
a. Provide and lead detailed classroom and hands-on training on the O&M of the specified product, system, subsystem, or component as specified in individual Specification Sections.
b. Provide two types of training at both pre-startup and post-startup:
1) Training for the OWNER's operations personnel.
2) Training for the OWNER's operations supervisors.

6. Pre-startup training: Complete a minimum of 14 days prior to actual startup.
7. Post-startup training: Complete within 14 days of startup.
8. Tape training sessions:
a. Provide audio and color video recording of pre-startup and post-startup instruction sessions for the OWNER's operations supervisors.
b. Shall be produced by a qualified, professional video production company unless the CONTRACTOR demonstrates the satisfactory skill of other acceptable personnel.
c. Provide two complete sets of DVDs, and the original video file, fully indexed and cataloged with printed labels stating the sessions and dates recorded.
d. The ENGINEER will furnish playback equipment.
e. Provide complete electronic copies of training materials including Microsoft PowerPoint presentations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. Manufacturer's Services:

1. General:
a. Conduct training in conjunction with operational testing and commissioning.
b. Schedule classroom training to be interspersed with logically sequenced field instruction.
c. Conduct training on consecutive days with no more than 6 hours of classes scheduled each day.
d. Submit O&M manuals as specified in SECTION 01 78 23 prior to training.
e. Minimum training shall include:
1) Microsoft PowerPoint presentation discussing equipment location and operational overview.
2) Purpose and function.
3) Operating theory.
4) Startup, shutdown, normal operation, and emergency operating procedures.
5) System integration and electrical interlocks.
6) Safety procedures.
7) Preventive maintenance.
8) Operator detection of trouble symptoms.
9) Exercise procedures and intervals.
10) Routine disassembly procedures.
11) Routine and long-term calibration procedures.
12) Review spare parts and recommendations.
f. Minimum field equipment training shall include:
1) Location of equipment and purpose.
2) Piping identification and flow operations.
3) Valve identification and purpose.
4) Instrumentation:
a) Primary element.
b) Instrument readout.
c) Purpose, basic operation, and information interpretation.

5) Demonstrate and perform standard operating procedures and routine checks.
6) Perform and demonstrate preventive maintenance activities.
7) Perform and demonstrate startup and shutdown procedures.
8) Perform and demonstrate required equipment exercise procedures.
9) Perform and demonstrate routine disassembly and assembly of equipment, if applicable.
10) Identify and review safety and perform safety procedures, if feasible.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 45 00
QUALITY CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for quality control.

B. Related Sections:

1. SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

1.2 DEFINITIONS

A. Quality Control (QC):

1. A system of procedures and standards by which a Constructor, Product Manufacturer, Materials Processor, or the like, monitors the properties of the finished Work.
2. QC is product-oriented. It is a process that is controlled and maintained by the CONTRACTOR throughout the life of the Contract. The CONTRACTOR is responsible for establishing and utilizing a QC program of the scope necessary to achieve the quality outlined in the Contract.
3. QC includes administrative and procedural requirements for activities to evaluate completed activities and elements for conformance with the requirements; includes the correction of defective construction.

1.3 SUBMITTALS

A. Submit a CONTRACTOR QC plan that includes the following items, commensurate to the complexity of the Project:

1. Features of Work.
2. The CONTRACTOR's QC Representative shall have experience on at least five separate projects similar in size and scope to this project with the role of planning, coordinating, scheduling, and documenting the QC activities for civil, structural, process, mechanical, electrical, instrumentation, HVAC, and piping systems.
3. Submittal procedures.
4. Roles and responsibilities.
5. QC requirements and procedures:
   a. Source QC procedures.
   b. Field QC procedures.
   c. Testing and inspection services.
   d. Plant inspection procedures.
   e. Testing laboratory services.
   f. Code-required special inspections and procedures.
   g. Pre-installation meetings.
6. Tracking construction deficiencies.
7. Documentation.
8. The QC plan shall be submitted within 30 days of the Notice to Proceed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. For additional quality control requirements, refer to the QC plan, the project management and coordination for pre-installation meeting, the coordination requirements specified in SECTION 01 31 00, and the individual Specification Sections.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 45 29
MATERIALS TESTING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information and execution for materials testing.
- B. Related Sections:
  1. SECTION 01 45 00 – QUALITY CONTROL

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 318 – Building Code Requirements for Structural Concrete
- B. ASTM International (ASTM):
  1. C 42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  2. C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
  3. D 2950 – Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
  4. D 3740 – Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
  5. D 5361 – Standard Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing
  6. D 6752 – Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
  7. E 329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

1.3 DEFINITIONS
- A. CONTRACTOR's QC: The operational techniques and the activities that sustain the quality of a product or service to satisfy given requirements of both the Contract Documents and the jurisdictional entity where the Work takes place. It consists of quality planning, data collection and analyses, implementation, installation, observation, and testing, and is applicable to all phases of the product life cycle: design, development, manufacturing, delivery and installation, and O&M.
- B. OWNER's QA: A program of testing and inspection performed by the OWNER to determine the level of quality and compliance with the requirements and standards of the Contract Documents.

1.4 SEQUENCING AND SCHEDULING
- A. General:
  1. Assist and cooperate with the OWNER and the ENGINEER for access to the Work to perform the OWNER's materials testing.
  2. CONTRACTOR's QC testing and reporting shall be required to satisfy the jurisdictional and permitting requirements.
  3. Provide documentation of planned QC testing as a part of the QC plan as specified in SECTION 01 45 00.

1.5 SUBMITTALS
- A. Qualifications: Provide documentation showing laboratory and personnel certifications for the QC tests required during construction.
  1. Laboratory certification in accordance with ASTM C 1077 and ASTM E 329 for the concrete tests to be performed in accordance with Division 3 specifications.
  2. ACI concrete field testing technician: Grade I certification for those administering the CONTRACTOR's QC concrete field testing.
  3. ACI concrete laboratory testing technician: Level I certification for those administering the CONTRACTOR's QC concrete laboratory testing.
  4. Laboratory certification in accordance with ASTM D 3740 for the soils and materials testing to be performed in accordance with Division 31 specifications.
- B. Testing Results: Provide results of the CONTRACTOR's QC testing performed for record purposes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 QUALITY CONTROL
- A. Soils Compaction Testing:
  1. The ENGINEER will perform the OWNER's QA testing of geotechnical materials and work product to determine the conformance of the Work with the requirements of the Contract Documents.
  2. The OWNER's QA program is for the sole use of the OWNER to determine the quality of the Work and is in no way intended to replace the CONTRACTOR's QC.
  3. The frequency of the OWNER's QA compaction testing will be in conformance with the accepted industry standard of care and at the ENGINEER's discretion.
  4. Areas of non-compliance, as determined by the OWNER's QA testing, shall be removed and re-compacted to conform to requirements of the Contract Documents upon receipt of test results. Costs for reworking and retesting backfill material to meet the requirements of the Contract Documents are at the CONTRACTOR's expense. Areas of non-compliance are defined as an area of a failing OWNER's QA test and extending to the nearest passing OWNER'S QA test on record.
- B. Concrete Testing:
  1. The ENGINEER will perform the OWNER's QA testing of the structural concrete components to determine the conformance of Work with the requirements of the Contract Documents. The frequency of the OWNER's QA testing will be at the ENGINEER's discretion.

2. The CONTRACTOR, at its discretion, may retain a qualified consultant to perform any necessary CONTRACTOR's QC testing to assist the CONTRACTOR in determining the state of materials incorporated into the Work. If the CONTRACTOR retains a consultant for the CONTRACTOR's QC, the ENGINEER may determine the OWNER's QA is unnecessary.
3. Assist the ENGINEER with concrete sampling and testing:
   a. Provide designated test site areas.
   b. Test sites shall be approximately 150 sf in area, level, and accessible at all times.
4. The OWNER's QA testers will verbally advise the CONTRACTOR of field test results upon completion of the respective tests.
5. The Concrete Supplier may perform its own QC testing.
6. Acceptance of concrete with failed compressive strength tests will be in accordance with ACI 318 and ASTM C 42.

C. Asphalt Compaction Testing:
1. The ENGINEER will perform the OWNER's QA testing of the asphalt pavement to determine conformance of the Work in accordance with the Contract Documents.
2. Retain a qualified consultant to perform the CONTRACTOR's QC testing as needed to ensure conformance with the Contract Documents, associated street cut permits, and occupancy permits in accordance with ASTM D 2950. The frequency of the CONTRACTOR's QC testing shall meet the requirements of the jurisdiction, street cut permits, and occupancy permits at a minimum.
3. The OWNER's QA testing will be completed after asphalt has been placed, compacted, and cooled.
4. Areas of nonconformance, as determined by the OWNER's QA testing, shall be removed, reinstalled, and re-compacted to conform with the requirements of the Contract Documents and any jurisdictional permits upon receipt of failed test results. Costs for removal, compaction, and retesting asphalt pavement to meet the requirements of the Contract Documents and jurisdictional permits are at the CONTRACTOR's expense.
5. Areas representing failed compaction tests may be cored and tested for density in accordance with ASTM D 5361 and ASTM D 6752 at the CONTRACTOR's expense.

D. Special Inspections and Testing: Special inspections and testing required by the building permit will be performed by the OWNER, or a third-party consultant hired by the OWNER, at the OWNER's expense.

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTION AND TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for special inspection and testing.

1.2 REFERENCES

A. International Code Council (ICC):
   1. International Building Code (IBC), Chapter 17, Section 1705 – Required Special Inspections and Tests
   2. International Building Code (IBC), Chapter 17, Section 1710 – Structural Observations

1.3 DEFINITIONS

A. Agencies and Personnel:
   1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be the OWNER when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
   2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
   3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which the Project is to be constructed.
   4. Special Inspector: A qualified person employed by the OWNER who will demonstrate competence to the satisfaction of the AHJ for inspection of a particular type of construction or operation requiring Special Inspection.

B. Statement of Special Inspections: Detailed written procedure as shown on the Drawings establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by the Special Inspector.

C. Special Inspection:
   1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with the approved Contract Documents and referenced standards.
   2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work is being performed.
   3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work has been or is being performed, and at the completion of the Work.

D. Structural Systems and Components:
   1. Diaphragm: Component of a structural lateral load resisting system consisting of a roof, floor, or other membrane or bracing system acting to transfer lateral forces to the vertical resisting elements of structure.
   2. Drag Strut or Collector: Component of a structural lateral load resisting system consisting of a diaphragm or shear wall element that collects and transfers diaphragm shear forces to the vertical force-resisting elements or distributes forces within a diaphragm or shear wall.
   3. Seismic-Force-Resisting System: That part of a structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces as shown on the Drawings.
   4. Shear Wall: Component of a structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on the Drawings, load bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
   5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces as shown on the Drawings.

E. Nonstructural Components:
   1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to the structure, including braces, frames, struts, and attachments.
   2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to the structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
   3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to the structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:
   1. Does not include or waives responsibility for required Special Inspection or inspections by the building official.
   2. Requirements are indicated on the Statement of Special Inspections as shown on the Drawings.
   3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to the Contract Documents.
   4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.4 COORDINATION

A. Statement of Special Inspections:
   1. As shown on the Drawings and in support of building permit application, Project-specific requirements were prepared by a registered design professional in responsible charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
      a. Special Inspection and testing in accordance with ICC IBC Section 1705 and other applicable sections and referenced standards therein.
      b. Type and frequency of Special Inspection required.
      c. Type and frequency of testing required.
      d. Required frequency and distribution of testing and Special Inspection reports to be distributed by the Special Inspector to the ENGINEER, CONTRACTOR, building official, and OWNER.
      e. Geotechnical observation to be performed: Required frequency and distribution of geotechnical observation reports by a registered design professional to the CONTRACTOR, building official, and OWNER.
      f. Structural observations will be in accordance with ICC IBC Section 1710 together with local and state amendments.

B. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by an AHJ approved, qualified inspection personnel. The OWNER will secure and pay for services of the agency to perform Special Inspection and associated testing.

C. Code required Special Inspection with associated testing, as provided in the Statement of Special Inspections as shown on the Drawings and as provided in this Section, is for the benefit of the OWNER.
   1. It does not relieve the CONTRACTOR of responsibility for providing adequate quality control measures.
   2. It does not relieve the CONTRACTOR of responsibility for damage to or loss of material before acceptance.
   3. It does not constitute or imply acceptance.
   4. It does not affect the continuing rights of the OWNER after acceptance of completed Work.

D. The presence or absence of a code required Special Inspector does not relieve the CONTRACTOR from the Contract requirements.

E. The CONTRACTOR is responsible for additional costs associated with Special Inspection and testing when Work is not ready at the time identified by the CONTRACTOR and Special Inspectors are on-site, but not able to provide contracted services.

F. The CONTRACTOR is responsible for associated costs for additional Special Inspection and testing by Special Inspectors required because of the rejection of materials of in-place Work that cannot be made compliant to the Contract Document without additional inspections and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the OWNER. Other testing and inspections, unless noted otherwise, are provided by the CONTRACTOR.

B. Provide access to the shop or site for Special Inspection and testing requirements.

C. Notify the ENGINEER in advance of the required Special Inspection no later than 2 days prior to the date of Special Inspection.

D. Provide access for the Special Inspector to the construction documents.

E. Retain Special Inspection records on-site to be readily available for review.

F. Cooperate with the Special Inspector and provide safe access to the Work to be inspected.

G. Submit the fabricator's certificates of compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Required auxiliary services include, but are not limited to the following:
   1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test and inspections.
   2. Providing storage space for the Special Inspector’s exclusive use, such as for storing and curing concrete test samples and the delivery of samples to testing laboratories.
   3. Providing the Special Inspector with access to approved Submittals.
   4. Providing security and protection of samples and test equipment at the Project site.
   5. Provide samples of materials to be tested in the required quantities.

I. Materials and systems shall be inspected during placement where continuous Special Inspection is required.

J. Where periodic Special Inspection is indicated in the Statement of Special Inspections:
   1. Schedule inspections for either during or at the completion of their placement or a combination of both.
   2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
   3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of Work requiring periodic inspection.

END OF SECTION

SECTION 01 50 00
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for construction facilities and temporary controls.

B. Related Sections:

1. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
2. SECTION 08 71 00 – DOOR HARDWARE
3. SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROL
4. SECTION 33 14 11 – WATER UTILITY TRANSMISSION AND DISTRIBUTION PIPING – GENERAL

1.2 REFERENCES

A. Environmental Protection Agency (EPA):

1. Federal Clean Water Act Section 402 – National Pollutant Discharge Elimination System (NPDES)

B. Mile High Flood District (MHFD):

1. Urban Storm Drainage Criteria Manual, Volume 3 – Stormwater Quality

C. National Fire Protection Association (NFPA):

1. 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations

D. U.S. Department of Transportation, Federal Highway Administration:

1. Manual on Uniform Traffic Control Devices (MUTCD)

1.3 COORDINATION

A. Safety Procedures:

1. Comply with the OWNER's safety rules while on the OWNER's property.
2. Notify the ENGINEER in writing of serious accidents on-site and any related claims.

B. Traffic Control:

1. As required by the jurisdiction issuing permits.
2. Traffic guidelines and control plan:
   a. Visual representation of lanes and intersections including work areas, parking and traffic lanes, islands, sidewalks, ramps, and crosswalks.
   b. Roadway, lanes, and sidewalk widths.
   c. Signs and devices in accordance with the MUTCD:
      1) Arrow boards to shift traffic.
      2) Cones and sidewalk closed signs at intersections or designated crosswalks.

1.4 SEQUENCING AND SCHEDULING

A. Mobilization:

1. Mobilization includes at a minimum:
   a. Obtaining required permits.
   b. Moving the CONTRACTOR's plant and the equipment required for operations onto the site.
   c. Installing temporary construction power, wiring, and lighting facilities.
   d. Providing on-site communication facilities including telephones.
   e. Providing on-site sanitary facilities and potable water facilities as specified and as required by laws and regulations and governing agencies.
   f. Arranging for and the erection of the CONTRACTOR's work and storage yard.
   g. Posting OSHA required notices and establishing safety programs and procedures.
   h. Having the CONTRACTOR's Superintendent at the site full-time.
   i. Providing the CONTRACTOR and the ENGINEER with field offices.
2. Use the area designated for the CONTRACTOR's temporary facilities as shown on the Drawings for the staging area or as designated by the ENGINEER.

1.5 SUBMITTALS

A. Administrative Submittals:

1. Copies of permits and approvals for construction as required by laws and regulations and governing agencies.
2. A copy of the application for permit prior to starting Work.
3. Provide copies of approved permits and keep originals on-site.

B. Shop Drawings: Temporary electric power supply and distribution plans.

C. Temporary Construction Submittals:

1. Access roads: Routes, cross-sections, and drainage facilities.
2. Parking area plans.
3. Storage yard and storage building plans including gravel surfaced area.
4. Fencing and protective barrier locations and details.

D. Temporary Control Submittals:

1. A plan for the disposal of waste materials and intended haul routes.
2. A plan for silt fence and straw bale installations.

1.6 QUALITY ASSURANCE

A. Permits:

1. Permits, licenses, or approvals: Obtain in accordance with the General Conditions and as may be provided in the Supplementary Conditions and retain on-site.

2. Apply for and conform to permits as required by federal, state, and local agencies.
    a. Water Discharge Permit:
        1) Apply for a WQCD permit that regulates discharges of water from construction sites.
        2) The permit is part of program delegated to Colorado by the EPA under the Federal Clean Water Act Section 402 NPDES.
        3) A permit is required for the Work.
        4) Discharge of recycled water is regulated by the CDPHE's WQCD. Recycled water shall not be discharged to any natural water body or storm sewer without a permit. A General Discharge Permit (COG604000 Hydrostatic Testing of Pipelines) shall be obtained from the WQCD prior to any recycled water being used for hydrostatic testing of the pipe as specified in SECTION 33 14 11.
        5) Handle the disposal of recycled water into a local sanitary sewer using the following procedure:
            a) Provide 30 days' notice to the ENGINEER for the OWNER to obtain necessary permits for discharge to sanitary sewers.
            b) The OWNER will not accept responsibility for impacts to the CONTRACTOR's schedule.
            c) The OWNER will furnish labor, necessary bulkheads, pumps, hoses, traffic control, and miscellaneous materials to dispose of recycled water into a manhole near tie-in locations. Discharge rates into the sewer system are typically limited to 100 gpm.
            d) Any unpermitted discharges of recycled water shall be reported to CDPHE's spill reporting line within 1 day of becoming aware of the discharge (1-877-518-5608), and the OWNER shall be notified in writing within 1 day of becoming aware of any unpermitted discharges.
    b. CDPHE:
        1) Stormwater discharges associated with construction activity.
        2) Groundwater discharges associated with construction activity permit.
    c. Sediment control permit.
    d. City and County permits:
        1) Obtain and comply with required permits.
        2) Traffic guidelines and control plan:
            a) Visual representation of existing striping, lanes, lane widths, sidewalk, sidewalk widths, curb ramps, signs, signal poles, and parking meters.
            b) Visual representation of proposed traffic control such as signs, advanced warning signs, barricades (including arrow boards and variable message boards), work areas, storage areas, construction fences, sidewalk closures, walkways, parking meter bagging/removal, and sign relocation.
            c) Signs and devices are required in accordance with the MUTCD.
        3) Parks Department: For Work occurring in parks or landscaped medians maintained by the Parks Department, obtain a temporary construction access permit.
    e. Submit applications for permits prior to beginning Work.
    f. Send copies of applications to the ENGINEER and the OWNER.
    g. Provide copies of approved permits to the ENGINEER and the OWNER and keep originals on-site.

1.7 SITE CONDITIONS

A. Existing Facilities: Refer to the Contract Documents for provisions relating to the CONTRACTOR's use of existing facilities.

PART 2 PRODUCTS

2.1 FABRICATION

A. ENGINEER's Field Office:
    1. On a date mutually agreed upon by the ENGINEER and the CONTRACTOR, furnish an office and the equipment specified herein for the exclusive use of the ENGINEER, the OWNER, and their Representatives if required in the Contract Documents.
    2. Ownership of the field office and the equipment furnished will remain that of the CONTRACTOR.
    3. The field office and the equipment furnished shall be new or like new in appearance and function.
    4. Provide one ENGINEER field office:
        a. Locate as shown on the Drawings or as directed by the ENGINEER.
        b. Minimum 400 sf.
        c. Minimum interior height: 8 feet.
        d. Minimum interior width: 10 feet.
        e. Floor plan: Two individual offices (80 sf each), one large meeting area, and one storage closet.
        f. Raise grade under office to an elevation adequate to avoid flooding.
        g. Construct on a properly sized foundation; provide surface drainage and connections for utility services.
        h. Level office and block, tie down, skirt, and install stairways.
        i. Provide a gravel parking area and a walking path.
    5. Communications: The OWNER will provide communication services to the ENGINEER's office and make the office ready to accept services.
    6. Components:
        a. 110 V, 60 Hz lighting and minimum of twelve duplex wall plugs; a minimum of two circuits, and ample electrical power and configuration to operate installed systems.
        b. Fluorescent ceiling lights providing 50 foot-candles at desktop height.
        c. Exterior light at each exterior door.

d. Electric heating and a self-contained air conditioning unit, properly sized for the Work locale and conditions, and capable of maintaining a temperature between 65ºF and 75°F.
e. Provide resilient floor covering.
f. A sign on the entrance door for the ENGINEER's office: "Engineer's Field Office."
g. Railed stairways and landings at the entrances.
h. Exterior doors:
    1) Quantity: Two.
    2) Type: Metal.
    3) Locks:
        a) As specified in SECTION 08 71 00.
        b) Provide two keys.
i. Windows:
    1) Quantity: Five.
    2) Provide security guard screens, operable sashes, and blinds or drapes.
j. Office equipment:
    1) Desks or built-in working surfaces with drawers in each office and desk chairs.
    2) One large meeting table to seat twelve, with chairs.
    3) One small table.
    4) Legal file cabinets with four locking drawers each, two keys: Four.
    5) One drafting table and stool.
    6) Bottled water service: A cooler capable of producing hot and cold water; water shall be renewed as requested by the ENGINEER.
    7) Paper cup dispenser with cups and refills as needed.
    8) Paper towel dispenser with towels and refills as needed.
    9) First-aid kit.
    10) Carbon dioxide, 10 lb, ABC Type, fire extinguisher: Two.
    11) Wastebaskets: Three.

PART 3 EXECUTION

3.1 GENERAL

A. Storage Yards and Buildings:
    1. As specified in SECTION 01 60 00.
    2. Items stored on-site are at risk of damage due to wind, animals, and other natural causes.
    3. Temporary storage yards: Construct temporary storage yards for the storage of products not subject to damage by weather.
    4. Temporary storage buildings:
        a. Store products subject to damage by weather in temporary structures.
        b. Provide environmental control systems that meet the recommendations of the Manufacturers of the equipment and materials stored.
        c. Arrange or partition to provide for the security of contents and ready access for inspection and inventory.
        d. Store combustible materials in a well-ventilated, remote building that meets local jurisdiction safety standards.
    5. Security fencing:
        a. If desired, construct a temporary security fence for the protection of materials, tools, and equipment.
        b. Maintain the fence during the construction period.
        c. Upon completion of Work, remove the security fence and restore the site.
    6. An existing building may be used for storage with the ENGINEER's written approval.
B. Parking Areas:
    1. Control parking to avoid interference with public traffic or parking, access by emergency vehicles, the OWNER's operations, or construction operations.
    2. Provide parking facilities for personnel working on the site.
    3. Parking is not permitted on the OWNER's existing paved areas, except as shown on the Drawings or as designated by the ENGINEER.

3.2 ERECTION

A. ENGINEER's Field Office:
    1. The ENGINEER's field office shall remain on-site and connected to utilities as required by the Contract Documents after the completion of Work.
    2. Clean the interior on a weekly basis including sweeping and wet mopping, removing debris, and emptying waste baskets.
B. Temporary Utilities:
    1. Power:
        a. If electric power is not available from the OWNER at the site, provide temporary electrical service approved by the ENGINEER.
        b. If electric power is available at the site, the ENGINEER will designate the power source.
        c. Determine the type and amount required and make arrangements for obtaining temporary electric power service from on-site facilities.
        d. Provide overcurrent protection devices, disconnects, transformers, conduit, conductors, and distribution equipment.

2. Lighting: Provide temporary lighting to meet the applicable safety requirements and to allow for the erection, application, and installation of materials and equipment, and the observation and inspection of Work.
3. Heating, cooling, and ventilating:
    a. Provide as required to:
        1) Maintain adequate environmental conditions to facilitate the progress of Work.
        2) Meet specified minimum conditions for the installation of materials.
        3) Protect materials, equipment, and finishes from damage due to temperature or humidity.
    b. Provide adequate forced air ventilation of enclosed areas to:
        1) Cure installed materials.
        2) Control humidity.
        3) Prevent hazardous accumulations of dust, fumes, vapors, or gases.
        4) Maintain temperatures.
    c. Pay the costs of installation, maintenance, operation, removal, and fuel consumed.
    d. Provide portable unit heaters:
        1) Complete with controls.
        2) Oil or gas-fired.
        3) Vented to the outside as required for the protection of health and property.
        4) If permanent natural gas piping is used, do not modify or reroute gas piping without the approval of the utility company, and provide separate gas metering, if required by the utility.
4. Water:
    a. Water will be available in accordance with ARTICLE 17 of the General Conditions.
    b. Use only special hydrant-operating wrenches to open hydrants.
    c. Make certain the hydrant valve is open fully.
    d. Repair damage from use, or the improper operation of hydrants.
    e. Maintain fire department access to hydrants at all times.
    f. Include costs to connect and transport water to construction areas, if required.
    g. Provide temporary facilities and piping required to bring water to the point of use; remove when no longer needed.
    h. For Work in the City and County of Denver Total Service and Read and Bill District Contract Areas, water used for construction purposes will be paid for by the OWNER in accordance with the requirements listed at https://www.denverwater.org/contractors/construction-information/hydrant-use-program .
    i. When potable water is not available at the site, make arrangements for and bear the costs of providing water required for drinking by construction personnel during construction.
5. Sanitary and personal facilities:
    a. Provide and maintain facilities for the ENGINEER's personnel, CONTRACTOR's employees, Subcontractors, and other on-site construction personnel.
    b. Service and clean twice weekly; maintain facilities and enclosures.
    c. Use of the OWNER's existing sanitary facilities by construction personnel is not allowed.
    d. Provide and maintain facilities for the ENGINEER's personnel through the Final Completion date.
6. Communication service:
    a. The CONTRACTOR's use of the OWNER's communication systems is not permitted.
    b. Arrange, provide, and pay for on-site communication services for the CONTRACTOR's use during construction.
7. Fire protection: In accordance with NFPA 241.

3.3 PROTECTION

A. General:
1. The OWNER provides ROW, easement, or site for permanent access or permanent construction for Work.
2. Additional access, access ROW, construction areas, or additional needed land involved in construction of the Work is the CONTRACTOR's responsibility and cost.
3. Land owned by the OWNER may be used as site headquarters, storage yard, or base of operations provided the use of said land meets the requirements and restrictions imposed by the OWNER at the time of usage.
4. Remove waste materials from the area and dispose of off-site.
5. Restore areas outside the Work used by the CONTRACTOR to the original condition upon completion of the construction.
6. Perform Work within the OWNER's property in a systematic manner that minimizes inconvenience to the OWNER and the public.
7. Do not block access to the OWNER's property from vehicular traffic.
8. Keep fire hydrants and water control valves free from obstruction and available for use.
9. Utilities:
    a. Maintain service utilities encountered in continuous operation unless other arrangements have been made with the utility owner.
    b. Where completion of Work requires the temporary or permanent removal or relocation of existing utilities, coordinate activities with the utility owner and perform Work to their requirements.
    c. In areas where the CONTRACTOR's operations are adjacent to or near a utility and operations could cause damage or inconvenience, suspend operations and provide protection of the utilities prior to proceeding.

d. Notify the ENGINEER and the utility owner in writing that they may be affected by construction operations at least 2 days in advance of Work.
e. Obtain the utility owner's permission prior to exposing utilities.
f. Protect, shore, brace, support, and maintain underground utilities that are uncovered or otherwise affected by construction operations.
g. If the service of a utility is interrupted due to the CONTRACTOR's operation, notify the proper authority immediately and cooperate with the authority to restore service as promptly as possible and bear the costs incurred.

10. Sewers:
    a. Do not impair the operation of existing sewer systems.
    b. Prevent construction debris from entering sewers, pump stations, or other sewer structures.
    c. Maintain original site drainage wherever possible.
11. Do not place solvents, non-food grade greases and oils, and other deleterious materials in the Work area. If Work requires equipment that utilizes deleterious materials, submit a containment plan to the ENGINEER for approval.

B. Finished Construction: Protect finished surfaces from damage by construction operations.
C. Waterways: Keep ditches, culverts, and natural drains continuously free of construction materials and debris.
D. Dewatering:
1. Construct, maintain, and operate cofferdams, channels, slurry trenches, flume drains, sumps, pumps, and other temporary diversion and protection measures.
2. Install, maintain, and operate pumps and other equipment for the environmentally safe removal and disposal of water.
3. Maintain excavations, foundations, and structures free from water.

E. Archaeological Finds:
1. If archaeological or paleontological finds are made within the limits of the site, notify the ENGINEER immediately and proceed in accordance with ARTICLE 4 the General Conditions.
2. Continue Work in other areas without interruption.

F. Signs:
1. Comply with applicable traffic control requirements as established by CDOT or the AHJ.
2. Provide signs that warn of construction traffic entering and leaving the site.

G. Tracking Pad: As shown on the Drawings.

3.4 QUALITY CONTROL

A. Temporary Controls:
1. Air pollution control:
    a. Minimize air pollution from construction operations.
    b. The burning of waste materials, rubbish, or other debris is not permitted on or adjacent to the site.
    c. Conduct operations to minimize dust. Provide dust-preventative measures for unpaved streets, roads, detours, and haul roads used in construction or periodically water to prevent dust. Visible dust is not allowed.
2. Noise control: Provide acoustical barriers to prevent noise emanating from tools and equipment from exceeding legal noise levels.
3. Water pollution control:
    a. Determine the method for diverting and disposing of sanitary sewer and rainstorm or snow melt runoff interfering with construction and therefore requiring diversion.
        1) Do not use the OWNER's existing sewer or overflow ponds for waste flow from construction operations.
        2) Do not cause an overflow of existing waterways.
    b. Prior to commencing excavation and fill, obtain the ENGINEER's approval of detailed plans showing procedures for the handling and disposal of sewage, groundwater, and stormwater or snow melt flow, including dewatering pump discharges.
    c. In accordance with MHFD Urban Storm Drainage Criteria Manual, Volume 3.
    d. Do not dispose of volatile wastes such as mineral spirits, oils, chemicals, or paint thinners in storm or sanitary drains or on land.
        1) The disposal of wastes into streams or waterways is prohibited.
        2) Provide containers for the collection and disposal of waste materials, debris, and rubbish.
    e. Obtain a stormwater permit for the Work, including the development of a SWMP, in accordance with requirements of the AHJ.
4. Erosion, sediment, and flood control:
    a. Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect Work and existing facilities from flooding during construction.
    b. Controls shall be in accordance with the approved SWMP and as specified in SECTION 31 25 00.

3.5 CLEANING

A. Provide progress cleaning during construction in accordance with the General Conditions and as specified in individual Specification Sections.
B. Use cleaning materials and methods recommended by the Surface Manufacturer of the surface to be cleaned and by the Cleaning Materials Manufacturer.
C. Repair or replace damage to any surface or substrate caused by the improper use of cleaning techniques or materials.
D. Provide approved containers for the collection of waste materials; when containers are full, promptly dispose of waste off-site in a manner complying with applicable ordinances and anti-pollution laws.

E. Exterior Surfaces:
   1. Wet down surfaces prior to sweeping to prevent the blowing of dust and debris.
   2. At least weekly, brush-sweep the entry drive, roadways, and other streets and walkways affected by the Work.
   3. Remove snow from access roads and the main entrance road within 1 day of each snow event.
F. At least weekly, sweep floors and roof and road surfaces and pick up and dispose of debris.
G. Neatly arrange stored construction materials.
H. Promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring and other damage.
I. Store wastes in approved, covered containers and remove daily.
J. Do not bury, burn, or dispose of waste into storm drains, sanitary sewers, streams, or waterways.Approval of progress payments will be dependent on the suitability of progress cleaning.

END OF SECTION

SECTION 01 51 36
TEMPORARY BYPASS SERVICE

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for temporary bypass service.
- B. Related Sections:
  1. SECTION 01 50 00 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1.2 DEFINITIONS
- A. Bypass Piping: A temporary above ground piping system from live fire hydrants that provides uninterrupted water service during the Work.
- B. Domestic Service: A service providing water for domestic use.
- C. ERT Device: An encoder, receiver, and transmitter installed in a water meter pit.
- D. Fireline: A 4 inch or larger service providing fire protection for buildings.

1.3 COORDINATION
- A. General:
  1. Provide bypass piping to supply water to facilities normally served by the water main that is out of service due to the Work.
  2. Temporarily connect each service line to bypass piping.
  3. Disconnect the service line from the bypass piping after the main has been cleaned and the service tap has been blown back.
  4. Domestic service lines:
     a. Meters are generally located near the property line in meter pits; some meters are located inside structures.
     b. For non-accessible hose bibs, or if equipped with an anti-siphon device, excavate and install bypass piping directly to the service line.
     c. The OWNER will remove ERTs from meter pits prior to the bypass piping connection and replace them after the bypass piping is removed.
     d. Do not handle ERTs.
     e. Notify the ENGINEER immediately when lead or galvanized service lines are encountered.
  5. Firelines:
     a. Firelines are shown on the Drawings and are generally not metered.
     b. Firelines require excavation to make a bypass piping connection.
     c. Procedures for connections to fire hydrants shall be as specified in SECTION 01 50 00.
     d. Fireline bypass piping shall be the same size as the fireline from the hydrant to the connection.

1.4 SUBMITTALS
- A. Shop Drawings: Detail ramp system used for above ground bypass pipe crossings of sidewalk and residential driveway crossings.
- B. Product Data: Bypass pipe and connections.

1.5 QUALITY ASSURANCE
- A. Bypass Piping:
  1. Provide water service to domestic services and firelines in the quantity and quality to prevent the interruption of the OWNER's customers' regular water demands.
  2. Make connections with minimum interruption to water service.
  3. Maintain O&M 24 hours a day, 7 days a week until the bypass service is removed.
  4. Provide bypass piping until pipelines are chlorinated, back in service, and the ENGINEER's approval for removal is obtained.
  5. Promptly correct damage to structures and property, service lines, water temperature problems, and water quality problems.
  6. If quality or temperature problems are not satisfactorily repaired in a timely manner, the OWNER will make repairs and the cost will be deducted from payments to the CONTRACTOR.
- B. Permits and ROWs: Obtain from the OWNER, at no charge, a permit to connect a bypass pipe to the OWNER's fire hydrants.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Atmospheric Hose Bib Vacuum Breaker:
  1. Watts, No. 8

2.2 MATERIALS
- A. Temporary Bypass and Connections:
  1. Bypass pipe:
     a. Domestic service:
        1) Domestic services 2 inches and smaller in diameter: 2 inch diameter.
        2) Domestic services 2 1/2 inches and 4 inches in diameter: 4 inch diameter.
        3) Domestic services larger than 4 inches in diameter: 6 inch diameter.
     b. Fireline service:
        1) Fireline services up to 4 inches in diameter: 4 inch diameter.
        2) Fireline services larger than 4 inches in diameter: 6 inch diameter.
     c. Minimum working pressure: 150 psi.

2. Connections:
    a. BSTCs.
    b. Minimum working pressure: 150 psi.
3. Material:
    a. Suitable for the conveyance of potable water.
    b. Suitable for traffic loads in areas subjected to heavy vehicle traffic.

PART 3 EXECUTION

3.1 PREPARATION

A. Bypass Piping:

1. General:
    a. Limit the amount of bypass piping installed and in service to an amount necessary for an orderly flow of Work.
    b. Prior to installation, inspect bypass pipe and connections, clean ends, and remove dirt from inside pipe.
    c. Obtain the ENGINEER's approval of variations in laying bypass pipe.
    d. At each hose connection on the bypass pipe, place an orange highway cone or highway standard Type I barricade.
    e. Maintain cones and barricades during the Work.
    f. Provide a PRV if crossing a pressure zone boundary.
2. Meters inside homes and businesses:
    a. For meters located inside homes or businesses, and if an anti-siphon valve is not present, connect to a hose bib.
    b. If a temporary connection cannot be made inside the structure or through other means, connect the bypass piping directly to the service line by excavating the service line and installing a 90 degree bend into the service line with bypass piping.
    c. Obtain the ENGINEER's approval prior to excavating the service line to connect bypass piping.
3. Chlorination and dechlorination:
    a. Before connecting bypass pipe to domestic services and firelines, follow the chlorination procedures of the OWNER.
    b. Assist with chlorination and dechlorination of the bypass pipe, mains, services, and firelines.
    c. Disassembly and re-assembly of bypass piping requires dechlorination and rechlorination.
4. Miscellaneous installation requirements:
    a. During the process of supplying temporary service, close curb stop valves. If valves are inoperable or do not sustain tight shutoff, notify the ENGINEER immediately and await the decision as to whether the curb stop valve is to be replaced. Payment for a curb stop valve replacement under the appropriate bid item shall be pre-authorized by the ENGINEER.
    b. If the curb stop valve box is filled with dirt, clean out the curb stop valve box so the valve can be operated.
    c. If the existing service line attached to the curb stop valve is in a condition warranting replacement, as determined by the ENGINEER, replace the service line from the main to the meter pit. Payment for a service line replacement under the appropriate bid item shall be pre-authorized by the ENGINEER.
    d. Install OWNER-furnished material for the repair or replacement of curb stop valves or service lines in accordance with DW's Engineering Standards.
    e. Do not obstruct sidewalk intersection ramps with bypass piping. Ramping over bypass piping is not permitted at sidewalk intersection ramps; re-route or bury bypass piping.
5. Street crossings:
    a. Where bypass pipe crosses asphalt or concrete streets, saw cut pavement to full depth and to a minimum width of 2 feet, bury bypass pipe and cover with cold-mix asphalt. Replace complete cut concrete panels after bypass operations have been completed.
    b. Where bypass pipe and service connection hoses cross sidewalks, residential driveways, and alleys, use either a preformed rubber ramp or a wooden ramp and cold-mix asphalt to the ramp over any obstruction caused by the temporary bypass system.
    c. Obtain the ENGINEER's approval for the ramp system prior to use.
    d. Bury bypasses at commercial driveways accessing businesses as shown on the Drawings and as required by the ENGINEER.
6. Unknown services and multiple connections:
    a. Additional taps and services not shown on the Drawings may exist that will require service from the temporary bypass pipe.
    b. When the pipeline is removed from service, if taps or services are discovered that are not shown on the Drawings, provide temporary service immediately by making a connection to the bypass pipe.
    c. Treat multiple connections to provide service to a single building or complex as one connection.
    d. If one of multiple connections to the same building or complex is a fireline, treat the connection as a fireline not as a domestic service.
    e. Treat separate connections for domestic services and firelines into the same building as separate connections.
    f. Install a check valve at fire hydrant connections.
7. Inclement weather/water quality considerations:
    a. If freezing or hot weather necessitates discharging water from the bypass pipe into gutters or storm sewers to prevent freezing or hot water accumulation, install a Watts No. 8 atmospheric hose bib vacuum breaker so that discharge water passes through the breaker.

b. Provide a vacuum breaker where required by the ENGINEER at no additional cost to the OWNER.
c. No additional payment will be made for materials and labor needed to mitigate freezing or hot water accumulation within bypass piping.

8. Temporary bypass fireline connection:
   a. Identify the location of fireline connections.
   b. Upon approval of the ENGINEER, excavate to the pipe along the course of the fireline to provide bypass service.
   c. Construct temporary service to fireline in a manner that eliminates leaks in the bypass system and is safe to the general public.
   d. Make temporary fireline connections to allow back flushing after cleaning and lining processes.
   e. Restrain fittings used in fireline connections in accordance with DW's Engineering Standards.
   f. Exercise special care with firelines containing alarm systems to prevent false alarms.
   g. Notify building management personnel prior to the installation of a temporary service.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 56 23
TEMPORARY BARRICADES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for temporary barricades.

1.2 COORDINATION

A. General:

1. Furnish flaggers, barricades, safety signs, warning signs, and devices to ensure the safety of the general public, recreationists, DW personnel, CONTRACTOR personnel, and the personnel of other agencies working in the vicinity of the Work.
2. Furnish and maintain CDOT Type 7 concrete barriers or equivalent barriers along the edge of the access road adjacent to the Work to minimize the amount of construction debris, rock, and soil entering the waterways or public areas.
3. Illuminate barricades marking hazard areas and equipment with flashing lights from sunset to sunrise.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 56 39
TEMPORARY TREE AND PLANT PROTECTION

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for temporary tree and plant protection.

1.2 REFERENCES
- A. American National Standards Institute (ANSI):
  1. Z60.1 – American Standard for Nursery Stock
- B. Council of Tree and Landscape Appraisers (CTLA):
  1. Guide for Plant Appraisal

1.3 DEFINITIONS
- A. Tree Protection Area:
  1. Ground encompassing the distance between the trunk and dripline, or 1 lf away from trunk base for every inch diameter of trunk, whichever is greater. Areas of ground covered by pavement, buildings, or other permanent structures where the presence of roots is minimal are excluded.
  2. Where groups of trees cause driplines to connect, protect the outer perimeter of connecting trees.
- B. Dripline: The outermost edge of a tree's canopy or branch spread.
- C. Critical Root Zone: The ground area included in the dripline.
- D. Diameter (Caliper):
  1. The size of a tree's trunk measured at:
     a. Trunk diameters up to and including 4 inches: 6 inches above grade.
     b. Trunk diameters of more than 4 inches up to and including 8 inches: 12 inches above grade.
     c. Trunk diameters greater than 8 inches: 4 1/2 feet above grade.
  2. Measure in accordance with the CTLA Guide for Plant Appraisal.
  3. Round measurements to the nearest inch.
- E. Arborist:
  1. Retained by the OWNER for the duration of the Work.
  2. An independent consultant with a degree in a field related to arboriculture.
  3. A minimum of 5 years of field experience in tree preservation, the on-site monitoring of public works, or construction projects involving tree retention and protection.
  4. An active member in the American Society of Consulting Arborists and the International Society of Arboriculture.
  5. A Landscape Architect registered in the State of Colorado.
- F. Forester: An officer having jurisdictional responsibility for maintenance of the forest.

1.4 COORDINATION
- A. General:
  1. Protect trees and plants as shown on the Drawings and those along any access route and in close proximity to the Work.
  2. Do not remove trees or plants, except those shown on the Drawings to be removed, without the written approval of the ENGINEER; disposal shall be in a legal manner off-site.
  3. Perform balling and burlapping of trees shown on the Drawings for replacement in accordance with ANSI Z60.1.
  4. Provide daily supervision of field crews by the Arborist during critical phases of the Work, including the demolition of existing concrete, root pruning, and construction in the tree protection area.
  5. Submit and obtain approval for the tree protection plan at the Forester’s office prior to beginning Work, if required.
  6. Designate routes for equipment and foot traffic prior to starting construction activities; indicate routes on the tree protection plan. Mark designated routes at the site prior to the start of Work; provide specified tree protection fencing and signage.
  7. Do not allow motorized equipment and trailers within tree protection areas.
  8. Do not drive over exposed tree roots. If motorized access is required within designated tree protection areas, notify the Arborist in writing and obtain approval of access and driving surface prior to its use.
  9. Do not stockpile or store materials and supplies within the tree protection area.
  10. If motorized access or temporary storage is approved within the designated tree protection areas, cover the existing grade with two overlapping layers of 3/4 inch thick plywood or 6 inches to 8 inches of wood mulch.
  11. Do not lean materials against the tree's trunk, branches, or exposed roots.
  12. Do not attach signs, cables, wires, nails, swings, or any other materials to trees that are not necessary for the support of the natural structure of the tree. Standard arboricultural techniques including bracing and cabling performed by professional arborists are acceptable.
  13. Secure tree pruning and removal permits prior to beginning Work, if required.

1.5 SUBMITTALS
- A. Proposed methods and schedule for tree and plant protection.
- B. Tree protection plan.
- C. CLS including the time frame for Work near existing plants. Obtain approval of the schedule from the ENGINEER prior to starting construction near tree protection areas.
- D. Submit proposed methods, materials, and the schedule for root pruning, branch pruning, and other tree maintenance.
  1. The Arborist will mark the location of root pruning lines in the field prior to beginning Work.
  2. Prune roots between autumn leaf fall and spring foliation.
  3. Obtain the approval of the Arborist if root pruning during the growing season is necessary.
- E. Provide a copy of tree pruning and removal permits.

1.6 QUALITY ASSURANCE
- A. Site Monitoring:
  1. Arborist duties:
     a. Monitor the site a minimum of two times weekly until procedures are understood and properly executed.
     b. Develop specific monitoring schedules at Pre-Construction Meetings and modify as necessary.
     c. Relay schedules to the Forester along with reports of site visits.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Root Restricting Barriers:
  1. Jason Mills, LLC
  2. REEMAY, Inc., Typar BioBarrier

2.2 MATERIALS
- A. Root Restricting Barriers:
  1. Stiff nylon woven fabric: 889 nylon fabrics with extra firm finish, Jason Mills, LLC.
  2. Copper wire screen: 14 mesh or smaller.
  3. Nylon fabric with holes approximately 1/26 inch square separated by strands approximately 1/26 inch thick, with strands fused together: Typar BioBarrier by REEMAY, Inc.
- B. Tree Protection Fences:
  1. Construct using one of the following materials:
     a. Galvanized chain-link, 6 feet high. Place posts on 10 foot centers maximum and at a minimum depth of 3 feet, without injury to surface roots and root flares of trees.
     b. Colored (orange), molded plastic construction fencing, 4 feet high.

PART 3 EXECUTION

3.1 PREPARATION
- A. Construction Procedures:
  1. Keep materials and equipment within the street bounded by existing curbs.
  2. Use caution during the removal of streets, curbs, gutters, sidewalks, drain inlets, and other concrete and asphalt; minimize injury to tree root systems.
  3. When removing existing concrete:
     a. Minimize ground disturbance and vibration.
     b. Remove curbs and sidewalks by hand within designated tree protection areas and critical root zones.
     c. Avoid injury to roots.
     d. Do not injure wood and bark tissues.
     e. Do not disturb exposed root systems and soil areas.
  4. Root treatment:
     a. Protect exposed roots from contamination by stabilization materials and concrete.
     b. Prune roots as specified in this Section.
     c. After proper pruning, cover exposed roots within 30 minutes with soil, mulch, or moistened burlap, 7 ounce or equivalent; keep roots moist until final grade is established.
     d. In areas where roots are removed, sever roots prior to excavation to eliminate the unnecessary tearing of roots by equipment.
     e. Excavate soil by hand at construction cut limit to a depth of 30 inches or to the depth of the required root cut, whichever is less.
     f. Install root restricting barriers where appropriate and under the direction of the Forester or the Arborist.
  5. Concrete installation:
     a. Locate concrete washout areas away from roots and tree protection areas.
     b. Place a sheet of 6 mil or thicker plastic over grade within affected portions of tree protection areas prior to placing concrete.
     c. Completely remove concrete and chemicals spilled within tree protection areas.
        1) Completely remove contaminated soil by hand at the time of a spill without disturbance to root systems.
        2) Add soil to restore grade.
  6. Do not deposit excavated soils on unprotected natural grades.
  7. Placing fill:
     a. Limit grading to a maximum of 2 inches of fill over the natural grade within critical root zones.
     b. Fill shall consist of sandy-loam topsoil. Do not use clay soils as fill.
     c. Scarify the existing surface to receive fill prior to filling.
     d. Do not place fill if soil is water saturated.
  8. Trees and high-value shrubs:
     a. Protect trees and high-value shrubs from injury.
     b. Mitigate injuries to trees and high-value shrubs in accordance with the guidelines established in the CTLA Guide for Plant Appraisal.
     c. Costs of such mitigation shall be paid for by the CONTRACTOR.
  9. Construction in critical root zones:
     a. Exercise care to avoid injury to trees and tree roots.
     b. Perform trenching and other Work by hand with approved hand tools.
     c. Tunnel or bore under tree roots 2 inches or larger in diameter and cover with moistened burlap.
     d. Hand prune roots smaller than 2 inches in diameter that are exposed in trenches.

e. Close trenches within 12 hours, or if not possible, cover trench walls with burlap and keep moistened.
f. Prior to backfilling, contact the Arborist to inspect the condition and treatment of roots that are larger than 2 inches in diameter injured by trenching.

3.2 APPLICATION

A. Tree and Plant Maintenance:

1. Minimum maintenance:
   a. Structural and remedial pruning.
   b. Watering.
   c. Mulching.
   d. Remediating soil compaction.
   e. Fertilization.
   f. Insect and disease control.
   g. Soil and tissue analysis.
   h. Aeration.
   i. Wound treatment.
2. The timing, duration, and frequency of maintenance will be determined by the Arborist based on factors associated with the site and the plants.

3.3 REPAIR

A. Injuries to Existing Plants – Damage Penalties:

1. Tree and high-value shrub appraisal:
   a. Trees and high-value shrubs will be evaluated and appraised by the Forester or the Arborist and a list of tree values for Work will be on file in the ENGINEER's office.
   b. Trees or plants requiring retention or protection that are not on the list will be appraised by the Forester or the Arborist as necessary to comply with this damage penalty.
2. Documentation for appraisals:
   a. Measurement of plant size.
   b. Identification by common and botanical names.
   c. Current condition including overall health, injuries, and overt hazard status.
   d. Location factors as described in the CTLA Guide for Plant Appraisal. Photographs shall be taken of certain trees and shrubs to document debilitating condition factors.
3. Only trees and shrubs with an estimated monetary value greater than $100 will be appraised.
4. Trees and other plants designated as requiring retention or protection are identified and located on the Drawings.
5. Loss of or injury to trees or plants due to the CONTRACTOR’s neglect or improper construction activities will result in a penalty of up to triple the damages of the assessed value of the tree as determined by the Forester or the Arborist.
6. A fine of $1,000 will be levied against the CONTRACTOR for each incident of construction damage within the designated tree protection areas. Fines are independent of damages for the assessed value of the tree or plant.
7. Damage to trees and plants will result in an assessment of damages based on the requirements herein; damages are for a period of 1 full year.

3.4 PROTECTION

A. Root Pruning:

1. Do not prune or cut tree roots unless removal is unavoidable or absolutely necessary.
2. Notify the Arborist prior to the cutting of more than:
   a. Two roots, 3 inches or more in diameter.
   b. Four roots, between 2 inches to 3 inches in diameter.
3. Notify the Arborist immediately if roots larger than the sizes described herein are cut, torn, ripped, or otherwise injured.
4. Prune tree roots within the designated area to a depth of 14 inches. Perform root pruning by hand or mechanical means with ENGINEER-approved tools.
5. Perform the removal of roots greater than 1 inch in diameter and parts of roots that are injured or diseased as follows:
   a. Preserve root bark ridge; similar in structure and function to branch bark ridge. Use directional root pruning during hand excavation around tree roots; cut objectionable and severely injured roots to the lateral root that is growing downward or in a favorable direction, if possible.
   b. Cut cleanly with sharp hand tools. Do not apply wound dressings.
   c. Approved root pruning tools:
      1) Scissor type lopper.
      2) Scissor type pruner.
      3) Large and small hand saws.
      4) Wound scriber.
      5) Trowel or small shovel.
      6) Garden fork.
      7) Hand broom.

B. Tree Protection Fencing:

1. Install tree protection fencing 2 feet behind the existing curb in areas where the street surface will be removed and replaced.

2. Tree protection areas are as designated on the Drawings. Stake fencing locations for approval by the ENGINEER and the Arborist.
3. Construct tree protection fences as specified in this Section.
4. Install fencing to completely surround the limits of tree protection areas and to extend at least 10 feet beyond designated construction limits.
5. Install tree protection fencing prior to any site activity and retain in place until Work is completed.

C. Tree Protection Signage: Mount a standard Forestry tree protection sign on tree protection fencing at 50 foot intervals. Signs may be obtained from the Forester's office, if required.

END OF SECTION

SECTION 01 58 13
TEMPORARY PROJECT SIGNAGE

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for temporary Project signage.
- B. Related Sections:
  1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  2. A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

1.3 SUBMITTALS
- A. Shop Drawings: Include the location, size, mounting height, and content of each sign.

PART 2 PRODUCTS

2.1 MATERIALS
- A. Temporary Construction Site Signs:
  1. Overall size: 96 inches wide by 48 inches high, unless otherwise specified by the ENGINEER.
  2. Material: Reflective sheeting applied to 1/8 inch thick aluminum.
  3. Reflective sheeting: E-panel dibond with anti-graffiti coating.
  4. Title characters: Bold, 125 point Gotham, in CAPS.
  5. Funded by names: 100 point bold Gotham.
  6. Body text characters: 96 point (medium Gotham, unless otherwise approved).
  7. Background color: Blue, (PMS Cyan), green (PMS 347), warm gray 9 (PMS) 75% opacity.
  8. Vehicular traffic signage: For use on public street Projects and Projects within the metropolitan area when the AHJ does not have pre-existing signage requirements.
     a. Provide the Project title, funding information, designers, and CONTRACTOR.
  9. Pedestrian traffic signage: For use on Projects in recreation areas when the AHJ does not have pre-existing signage requirements:
     a. Provide the Project title, Project construction beginning and end dates, and the purpose of the Project. Include company logos if applicable.
- B. Steel Tube: In accordance with ASTM A 500.

2.2 ACCESSORIES
- A. Posts: A 2 inch diameter galvanized steel tube with a steel plate cap welded on, hot-dip galvanized after fabrication in accordance with ASTM A 123, G90 coating class.
- B. Concrete: Class B as specified in SECTION 03 30 00.
- C. Fasteners: Galvanized steel, the type best suited to the application, with vandal-resistant heads.

PART 3 EXECUTION

3.1 GENERAL
- A. Be responsible for determining if the AHJ has existing signage requirements. If the AHJ does not have pre-existing signage requirements, this Section shall apply.
- B. Be responsible for the creation of the sign and its expense.
- C. The sign shall be placed, at the direction of the ENGINEER, in close proximity to the immediate work; it shall be highly visible to the public.
- D. Maintain the sign in good condition during the performance of the Work. Prior to the Final Completion date, or when otherwise directed by the ENGINEER, remove and dispose of the sign at the CONTRACTOR's expense. Relocation of the sign during the duration of the Work is not required unless directed to do so by a Representative of the local AHJ.
- E. The sign shall be erected a minimum of 2 weeks prior to the start of the Work or sooner if required by the AHJ.
- F. The language of the temporary construction site sign shall be approved by the ENGINEER prior to printing.

3.2 INSTALLATION
- A. Install signs as shown on the approved Shop Drawings at a location specified by the ENGINEER.
- B. Set plumb, level, and secure.
- C. Dome the top of the concrete footing to shed water.
- D. Brace signs until concrete has set.
- E. Secure signs to posts with two fasteners.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 60 00
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for material and equipment.

B. Related Sections:

1. SECTION 01 50 00 – CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS
2. SECTION 01 91 00 (.01 or .02) – COMMISSIONING

1.2 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by the CONTRACTOR or the OWNER for the Work or taken from previously purchased stock. This may also include existing materials or components required for reuse.
2. Includes terms, material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent.
3. Items identified by the Manufacturer's product name, including make or model designation, indicated in the Manufacturer's published product literature, current as of the Effective Date of the Agreement.

1.3 SUBMITTALS

A. Administrative Submittals:

1. A schedule of the factory tests in accordance with Contract Documents. Identify the tests for which the ENGINEER's presence is requested.
2. Factory testing schedule.

B. Quality Control Submittals:

1. Factory tests: As specified in individual Specification Sections.
   a. Procedures: Preliminary outlines.
   b. Final accepted procedures: Prior to the start of factory testing.
   c. Test documentation: The results of successful testing, including the certification of procedures and results.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Make deliveries by way of approved access.

B. Deliver products in accordance with the accepted current CLS and coordinate to avoid conflict with Work and conditions at the site. Deliver anchor bolts and templates sufficiently early to permit setting prior to the placement of structural concrete.

C. Deliver products in an undamaged condition, in the Manufacturer's original container or packaging, with identifying labels intact and legible. Include on the label the date of manufacture and shelf life, where applicable. Include UL labels on products so specified.

D. Unload products in accordance with the Manufacturer's instructions for unloading, or as specified. Record receipt of products at the site. Inspect for completeness and evidence of damage during shipment.

E. Remove damaged products from the site and expedite delivery of identical new undamaged products and remedy incomplete or lost products to provide that specified, so as not to delay the progress of the Work.

F. Handle products in accordance with the Manufacturer's instruction, and in a manner as to prevent damage. Store products, upon delivery, in accordance with the Manufacturer's instructions, with labels intact and legible, in approved storage yards or sheds provided as specified in SECTION 01 50 00. Provide the Manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by the ENGINEER.

G. Arrange storage in a manner as to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions and free from damage or deterioration. Keep a running account of products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

H. Store electrical, instrumentation, and control products, and equipment with bearings in weathertight structures maintained above 60°F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and continuously operate space heaters furnished in electrical equipment.

I. Store fabricated products above ground on blocking or skids and prevent soiling or staining. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

J. Store finished products that are ready for installation in dry and well ventilated areas. Do not subject to extreme changes in temperature or humidity.

K. Hazardous Materials: Prevent the contamination of personnel, the storage building, and the site. Meet the requirements of product specifications, codes, and Manufacturer's instructions.

L. On-site Storage:

1. Use designated land belonging to the OWNER on or near the site of the Work, for the storage of materials and equipment.
2. If additional area is required, lease or gain permission to use additional land.
3. Obtain approval for the location and layout of storage prior to material delivery.
4. Off load packages and equipment where directed.
5. Move stored materials or equipment if access is required to the storage area.
6. Protect packages from exposure to weather.

M. Off-site Storage:
1. Obtain approval from the OWNER for materials and equipment not incorporated into Work but included in the Applications for Payment. Present off-site storage arrangements in writing.
2. Provide security, protection, and bonding.
3. Provide access to facilities to the ENGINEER.
4. In accordance with ARTICLE 14 of the General Conditions.

N. Preparation for Shipment:
1. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
2. Package products to facilitate handling and protect them from damage during shipping, handling, and storage. Mark or tag the outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and Bills of Materials with each shipment.
3. Protect painted surfaces against damage. Repair and repaint painted surfaces damaged prior to the ENGINEER's acceptance of equipment.
4. Spare parts, special tools, test equipment, expendables, and maintenance materials:
   a. Furnish as required, prior to starting ORT as specified in SECTION 01 91 00, the operation of equipment by the OWNER, or 75% of the Substantial Completion date, whichever occurs first.
   b. Properly package to avoid damage, in original cartons. Replace parts that are damaged or otherwise inoperable.
   c. Firmly fix to, and prominently display on, each package.
      1) Minimum 3 inch by 6-inch manila shipping tag with the following information printed clearly:
         a) Manufacturer's part description and number.
         b) Applicable equipment description.
         c) Quantity of parts in package.
         d) Equipment Manufacturer.
         e) Applicable Specification Section.
         f) Name of CONTRACTOR.
         g) Project name and Contract number.
   d. Deliver materials to the site.
   e. Notify the ENGINEER upon arrival.
   f. Inspect and transfer to the ENGINEER via detailed transmittal.
5. Protect equipment from exposure to the elements and keep dry and dust free. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil bearings and similar items.
6. Factory test results: Reviewed and accepted by the ENGINEER before product shipment as specified in individual Specification Sections.

PART 2 PRODUCTS

2.1 MATERIALS

A. General:
1. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
2. Manufacturers:
   a. Provide the Manufacturer's standard materials suitable for service conditions unless otherwise specified in individual Specifications.
   b. Where product specifications name the Manufacturer and also include performance requirements, the named Manufacturer's products shall meet performance specifications.
   c. Like items of products shall be end products of one Manufacturer and of the same series or family of models to achieve standardization.
   d. Provide interchangeable components of the same Manufacturer for similar components, unless otherwise specified.
3. Equipment, components, systems, subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and compliance shall be in accordance with applicable OSHA, state, and local health and safety regulations.
4. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of VOCs and worker exposure.
5. Safety guards:
   a. Provide for belt or chain drives, fan blades, couplings, or other moving or rotary parts.
   b. Cover rotating part on sides.
   c. Design for easy installation and removal.
   d. Use minimum 16 gauge galvanized steel, aluminum coated steel or galvanized or aluminum coated steel or 1/2-inch mesh expanded steel.
   e. Provide galvanized steel accessories and supports, including bolts.
   f. For outdoors application, prevent the entrance of water.
6. Provide the materials and equipment listed by UL wherever standards have been established by that agency.
7. Equipment finish:
   a. Provide Manufacturer's standard finish and color, except where a specific color is shown on the Drawings.

b. If the Manufacturer has no standard color, provide equipment with ANSI 61, light gray color.
8. Special tools and accessories: Furnish accessories required to place each item of equipment in full operation.
9. Lubricant: Provide lubricant recommended by the equipment Manufacturer in a sufficient quantity to fill lubricant reservoirs and to replace consumption during the testing, startup, and operation until final acceptance.

2.2 FABRICATION

A. General:
1. Manufacture parts to U.S. standard sizes and gauges.
2. Design structural members for anticipated shock and vibratory loads.
3. Use 1/4 inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
4. Modify standard products as necessary to meet performance specifications.

B. Lubrication System:
1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible:
a. Provide oil drains with bronze or SST valves and fill plugs easily accessible from the normal operating area or platform.
b. Locate drains to allow for the convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings that are not easily accessible, provide and install SST tubing extended to a convenient location with a suitable grease fitting.

PART 3 EXECUTION

3.1 INSTALLATION

A. Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
B. Verify the dimensions shown on the Drawings as they may vary depending upon the equipment furnished.
C. No shimming between machined surfaces is allowed.
D. Repaint surfaces that are damaged prior to equipment acceptance.
E. Handle, install, connect, clean, condition, and adjust products in accordance with the Manufacturer's instructions and as may be specified. Retain a copy of the Manufacturer’s instructions at the site that are available for review.

3.2 QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by the ENGINEER, notify the ENGINEER in writing no less than 14 days prior to the scheduled test date.
B. Calibration Instruments: Bear the seal of a reputable laboratory certifying the instrument has been calibrated within the previous 12 months to the standard endorsed by the NIST.
C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.
D. Inspect materials and equipment for signs of pitting, rust, decay, or other deleterious effects of storage. Do not install material or equipment showing such effects.
E. Remove damaged material or equipment from the site and expedite the delivery of identical new material or equipment.
F. Delays to Work resulting from material or equipment damage are delays within the CONTRACTOR’s control.
G. For material and equipment shown on the Drawings or specified to be reused in the Work:
1. Use special care in the removal, handling, storage, and reinstallation to ensure proper function in the completed Work.
2. Arrange for the transportation, storage, and handling of products that require off-site storage, restoration, or renovation.

3.3 STARTUP

A. Perform required adjustments, tests, operation checks, and other startup activities.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 64 00
OWNER-FURNISHED PRODUCTS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general requirements, products, and execution for OWNER-furnished products.
- B. Related Sections:
  1. SECTION 01 91 00 (.01 or .02) – COMMISSIONING

1.2 DEFINITIONS
- A. Manufacturer: Where Manufacturer is referred to in this Section, it refers to the person, firm, or corporation retained by the OWNER in a separate agreement to provide products purchased by the OWNER. Such party may be referred to as the CONTRACTOR for OWNER-furnished products or OWNER-furnished equipment CONTRACTOR in other Sections of the Contract Documents.
- B. Products: Equipment, valves, fittings, and other components furnished by the OWNER.
- C. Transfer:
  1. Transfer of OWNER-furnished products to the CONTRACTOR refers to the times when the following have occurred:
     a. Manufacturer's instructions for loading, unloading, handling, storage, protection, and installation received by the CONTRACTOR.
     b. Products delivered to the OWNER'S Warehouse – Building H: 1600 W. 12th Avenue, Denver, CO 80204.
     c. The OWNER determined the products as ready for loading, unloading, storage, protection, and installation by the CONTRACTOR.

1.3 COORDINATION
- A. CONTRACTOR's Responsibility for Complete System:
  1. Storing, handling, installing, adjusting, and maintaining of OWNER-furnished products. Assist the Manufacturer with the pre-startup lubricating and operational startup of OWNER-furnished products. Provide and coordinate the construction of interconnecting structures, products, piping, and appurtenances to achieve installation and operation of the OWNER-furnished products to provide a complete and functional system in accordance with the Contract Documents.
  2. Coordinate the electrical and instrumentation Work as necessary to achieve installation and operation of OWNER-furnished products in accordance with the Contract Documents to provide a complete and functional system.
  3. Conduct field tests as specified herein and correct issues related to installation.
- B. ENGINEER's Responsibility for Information:
  1. The ENGINEER will make the following information available for the CONTRACTOR's use:
     a. Shop Drawings of OWNER-furnished products, including revisions as they affect the installation Work.
     b. Manufacturer's storage, installation, O&M instructions for OWNER-furnished products.

1.4 SEQUENCING AND SCHEDULING
- A. Provide products required to complete the Work in this Section, except where specified as OWNER-furnished. Such products include, but are not limited to, concrete bases, piping, gaskets and accessories, specialties, and expendable materials, as necessary to provide a complete and properly functioning system.
- B. Verify availability of OWNER-furnished products by contacting the ENGINEER before making final arrangements for, or committing resources to, handling, storage, protection, or installation of such products.
  1. OWNER-furnished products will be available for CONTRACTOR pick up at DW's Warehouse, 1600 W. 12th Avenue, Denver, CO 80204. Transport material from this location to the Work site(s).
  2. OWNER-furnished product will be made available on the date determined by the OWNER.

1.5 SUBMITTALS
- A. Upon Notice to Proceed, the CONTRACTOR shall be responsible for ownership, delivery, and care of pre-selected products.
- B. Certificate of Acceptable Receipt, Delivery, Unloading, and Storage as approved by the OWNER.
- C. Shop Drawings:
  1. Detailed Drawings that indicate the layout, location, and identification of products and materials provided by the CONTRACTOR:
     a. Include pipes, fittings, valves, hangers, supports, products, and required specialties.
     b. Electrical and instrumentation diagrams to indicate connecting and interconnecting electrical and control Work.
  2. Plans to repair or replace products that become damaged or lost after transfer to the CONTRACTOR for storage and protection.
- D. Supplements listed in this Section.

1.6 QUALITY ASSURANCE
- A. General:
  1. Furnish the tools, supplies, materials, products, and labor necessary for the installation, testing, and placing into operation of products and appurtenances, complete and operable, in accordance with the Contract Documents.
  2. The provisions of this Section shall apply to the products specified, except where otherwise indicated in the Contract Documents.
- B. Contractor's Responsibility for Complete System:
  1. Conduct field tests as specified in this Section and SECTION 01 91 00; correct issues related to installation.
- C. Manufacturer's Responsibility for Products:
  1. The Manufacturer of the OWNER-furnished products shall be responsible for providing the following:
     a. Factory testing and certification of test results.
     b. O&M manual, including installation and storage instructions.

c. Inspection and acceptance of the CONTRACTOR's product installations.
d. Certificate of proper installation.
e. Field services, to include inspection and certification of proper installation, startup, and testing assistance.
f. Training of the OWNER's personnel.

2. After completion, the Manufacturer shall furnish written guarantees to the ENGINEER that products will operate as required.

D. Manufacturer's Service Representative: Installation, testing, and startup assistance specified in the Manufacturer's purchase contract.

E. Engineer's Responsibility for Information: The ENGINEER will make the following information available for the CONTRACTOR's use: Shop Drawings of OWNER-furnished products, including revisions as they affect the installation Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Necessary storing, handling, installing, adjusting, and maintaining of OWNER-furnished products shall be the CONTRACTOR's responsibility. Assist the Manufacturer with the pre-startup and operational startup of OWNER-prepurchased products.

B. Storage and Protection:

1. Following the transfer of OWNER-furnished products and until final acceptance of the completed Work, protect and maintain products to prevent damage.
2. Damage to or loss of products after the date of their transfer to the CONTRACTOR shall be repaired to the original condition or replaced with new identical products, as reviewed and accepted by the ENGINEER.
3. The Manufacturer shall inspect the OWNER-furnished products for signs of potting, rust, decay, or other deleterious effects of improper storage just before installation, and shall notify the ENGINEER of the results of the inspection.

PART 2 PRODUCTS

2.1 COMPONENTS

A. General: Provide products required to complete Work under this Section, except where specified as OWNER-furnished.

B. Products: OWNER-furnished products shall consist of the products described in this Section and appended in the Contract Documents.

C. Miscellaneous Products: Furnish incidental products for the proper operation of products installed in this Section. Products for the intended service shall be in accordance with the Contract Documents.

PART 3 EXECUTION

3.1 GENERAL

A. Installation Work shall conform to the Manufacturer's recommended procedures, instructions, and Shop Drawings as reviewed and approved by the ENGINEER.

B. Maintain a complete inventory on OWNER-furnished products after the product's transfer to the CONTRACTOR.

C. Coordinate electrical connections with the OWNER for the proper operation of products.

D. Perform installation of OWNER-furnished products.

E. The setting of the product bases by the CONTRACTOR shall be acceptable to the OWNER and the Manufacturer.

F. Install piping, valves, and miscellaneous fittings in accordance with the Manufacturer's instructions and the Contract Documents.

G. Perform electrical connections in accordance with the Contract Documents.

3.2 PREPARATION

A. Installation: Consult the Manufacturer for installation instructions.

B. Inspection of Products:

1. Before the transfer of OWNER-furnished products to the CONTRACTOR, the CONTRACTOR and the ENGINEER shall jointly inspect the condition of each product.
2. Record, in writing, the products transferred to the CONTRACTOR. Complete the form included at the end of this Section.
3. Damage to or loss of products and materials shall be immediately reported to the ENGINEER.
4. Damage or loss of products and materials after the date of transfer to the CONTRACTOR shall be repaired or replaced at the CONTRACTOR's expense, and as directed by the ENGINEER.

3.3 INSTALLATION

A. Maintenance:

1. Immediately after installation, apply pre-startup lubricants in accordance with the Manufacturer's instructions.
2. Follow the Manufacturer's instructions for maintenance during storage, after installation but prior to testing and startup, and after startup but prior to the OWNER's acceptance.

B. The product installation Work shall include the installation of OWNER-prepurchased products as shown on the Drawings. Work associated with the product installation shall be performed by the CONTRACTOR. The field quality control work including the recording of field measurements, assistance with product startup, and conducting the functional and performance testing shall be performed by the CONTRACTOR.

C. Install products in accordance with approved procedures submitted with the Manufacturer's printed instructions.

D. Provide supervision, labor, tools, construction product, incidental materials, and necessary services required to install OWNER-furnished products.

3.4 PROTECTION

A. Following the transfer of OWNER-furnished products and until final acceptance of the completed Work, protect and maintain products to prevent damage.

B. Damage to or loss of products after the date of the product's transfer to the CONTRACTOR shall be repaired to the original condition or replaced with new, identical products as reviewed and approved by the ENGINEER.

C. The Manufacturer shall inspect the products for signs of pitting, rust decay, or other deleterious effects of improper storage just before installation, and shall notify the ENGINEER of the inspection results.

3.5 QUALITY CONTROL

A. Give full access to Work by, and cooperate with, the Manufacturer during testing to enable the gathering of data and information necessary to evaluate performance and develop recommendations for acceptable O&M instructions.

B. Inspection of Products:

1. Complete the Certification of Acceptable Delivery, Unloading, and Storage form included at the end of this Section.
2. Damage to or loss of products and materials shall be immediately reported to the ENGINEER.
3. Damage to or loss of products and materials after the date of transfer to the CONTRACTOR shall be repaired or replaced at the CONTRACTOR's expense.

3.6 STARTUP

A. Coordinate the requirements listed in SECTION 01 91 00 regarding commissioning and startup unless otherwise specified.

3.7 SUPPLEMENTS

A. Supplement A – Certificate of Acceptable Receipt, Delivery, Unloading, and Storage

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A
CERTIFICATE OF ACCEPTABLE RECEIPT, DELIVERY, UNLOADING, AND STORAGE

To: ENGINEER

_____

_____

_____

Attention: _____

Regarding: _____

The undersigned representing _____, hereinafter called the CONTRACTOR, certifies that the _____ (name product)

was delivered, unloaded, stored, and maintained in accordance with the recommended procedures and precautions and accepts the transfer of the above product with observed defects noted as follows (if any): _____

_____

_____

_____

Signed this _____ day of _____, 20_____.

By: _____

INTENTIONALLY BLANK

SECTION 01 71 23.16
CONSTRUCTION SURVEYING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for construction surveying.

B. Related sections:

1. SECTION 01 40 00 – QUALITY REQUIREMENTS

1.2 COORDINATION

A. Survey:

1. Complete and submit a survey work request to the Survey Manager and/or ENGINEER.
2. The OWNER will provide horizontal and vertical survey control for the Work in accordance with Paragraph 4.4 of the General Conditions.
3. Perform surveys necessary to lay out the structure and pipeline lines, alignments, grades, and elevations from the OWNER's provided control points.
4. The ENGINEER may review or verify the CONTRACTOR-established lines, grades, and elevations by surveys. Provide access to Work for these surveys.
5. Reviews or surveys performed or requested by the ENGINEER shall not relieve the CONTRACTOR's responsibility for correct lines, grades, elevations, and structure layout.

B. Construction Layout:

1. Perform construction layout using qualified, competent personnel.
2. Stake pipelines at horizontal PIs, grade changes, and at 50-foot intervals or less.
3. Make survey data available for review throughout the construction time period.
4. Enter survey notes and construction stakeout cut notes into a hard cover field book or other electronic field note format.
    a. Submit a copy of cut sheets for review a minimum of 1 1/2 days in advance of construction activities.
    b. By the Substantial Completion date, submit data developed by surveys.

C. Field Engineering: Perform quality control as specified in SECTION 01 40 00.

1.3 SUBMITTALS

A. Survey Work Request Form.

B. Survey cut sheets notes and data.

1.4 SITE CONDITIONS

A. Control Points:

1. Protect and preserve control points and benchmarks.
2. Report damaged or destroyed control points and benchmarks to the ENGINEER.
    a. The ENGINEER will re-establish damaged, moved, altered, or destroyed horizontal and vertical survey control.
    b. If damaged, moved, altered, or destroyed by the CONTRACTOR, the cost of re-establishing such points shall be borne by the CONTRACTOR.
    c. The ENGINEER is not responsible for increased costs or delays to the CONTRACTOR relating to control points or benchmarks that are damaged, moved, altered, or destroyed by the CONTRACTOR or its Subcontractors, Suppliers, Agents, or Employees or other Contractors working on-site.
3. Report potential errors in control points or benchmarks to the ENGINEER.
    a. Discontinue the use of control points or benchmarks alleged to be in error until the accuracy of such points can be verified.
    b. Claims for extra compensation for the alteration or reconstruction allegedly due to errors in control points or benchmarks is not allowed unless original control points and benchmarks still exist or substantiating evidence proving the error is furnished by the CONTRACTOR, and unless the CONTRACTOR has reported such errors to the ENGINEER as specified herein.
4. Use of primary control points for construction surveying, other than those shown on the Drawings or furnished by or approved by the ENGINEER, is prohibited.
5. Prior to beginning Work, the CONTRACTOR's Surveyor shall perform a survey to verify survey control points, range points, PLSS corners, and benchmarks as shown on the survey control diagram.
6. Range points:
    a. Protect existing range points and PLSS monuments as described below:
        1) Range points and PLSS monuments disturbed during construction shall be resurveyed and restored by the OWNER and paid for by the CONTRACTOR in accordance with local jurisdiction guidelines and requirements for range points.
        2) Prior to disturbing a range point or PLSS monument, notify the OWNER that the information required to reset the monument has been prepared, stamped, and signed by a Professional Land Surveyor registered in the State of Colorado.
        3) The OWNER will withhold resurveying and restoration services, offered above, for circumstances related to the CONTRACTOR's neglect to provide adequate notification of potential range or control point disturbance; the responsibility and cost for surveying and restoration shall become the CONTRACTOR's.
        4) The OWNER will collect information to resurvey and restore range points and PLSS monuments prior to the beginning of Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Construction Lines and Grades:

1. CONTRACTOR:
   a. Make and maintain points and lines in connection with the surveys required.
   b. Provide offset line from which the centerline and grade of the pipeline can be controlled and monitored.
   c. Preserve line and grade stakes and markers set by the ENGINEER until otherwise authorized.
   d. Submit a Survey Work Request Form to the ENGINEER a minimum of 5 days prior to the date the survey is needed.
2. OWNER:
   a. Provide construction surveys to establish offset control points parallel to the proposed pipeline alignment.
   b. The offset distance shall be determined by a joint effort between the CONTRACTOR and the ENGINEER, relative to trench width and site conditions.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for closeout procedures.

1.2 SUBMITTALS

A. Quality Control Submittals: Written procedures for maintaining and markup of Record Documents.

B. Contract Closeout Submittals: Submit in accordance with the General Conditions and as specified in individual Specification Sections:

1. Record Documents.
2. Approved Shop Drawings.
3. O&M data and final equipment O&M manuals.
4. Commissioning, startup, and testing documentation.
5. Warranties, bonds, and service agreements.
6. Consent of surety to final payment.
7. Releases or waivers of liens and claims.
8. Releases from Agreements.
9. Final Application for Payment.
10. Spare parts and special tools.

C. Upon completion of closeout activities, submit an Application for Final Payment and a completed Final Payment Release Form as detailed in the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CLEANING

A. At completion of the Work and prior to the Final Completion date, remove tools, equipment, surplus materials, debris, and temporary construction from the premises. Leave Work and adjacent areas in clean condition.

B. Remove grease, dirt, dust, paint, stains, and other foreign materials resulting from Work from street surfaces and surrounding areas.

C. Use cleaning materials and methods recommended by the Surface Manufacturer of the surface to be cleaned and by the Cleaning Materials Manufacturer.

D. Repair damage to any surface or substrate caused by the improper use of cleaning techniques or materials.

E. Repair, patch, and touch up marred surfaces to match adjacent surfaces.

F. Broom clean paved surfaces.

G. Leave watercourses, gutters, and ditches open and clean.

H. Haul waste from the jobsite to an approved disposal area.

I. Return grassed areas disturbed by Work to original grade and re-seed or re-sod.

J. Replace any cracked curb and gutter damaged during execution of the Work.

K. Remove cold mix asphalt from areas used to cross bypass pipe.

END OF SECTION

INTENTIONALLY BLANK

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information for operation and maintenance data.

B. Related Sections:

1. SECTION 01 29 00 – PAYMENT PROCEDURES
2. SECTION 01 32 20 – ELECTRONIC DOCUMENT MANAGEMENT SYSTEM
3. SECTION 01 33 00 – SUBMITTAL PROCEDURES
4. SECTION 01 77 00 – CLOSEOUT PROCEDURES

1.2 SUBMITTALS

A. At the OWNERS discretion, the EDMS may be used to submit and approve O&M manuals as specified in SECTION 01 32 20.

B. O&M Manual Outline: Submit a detailed outline of each O&M manual prior to the preparation of preliminary 90 days before first installation.

C. Preliminary O&M Manuals for Equipment and Systems:

1. Submit not less than 60 days prior to installation of equipment.
2. Submit three copies for the ENGINEER's review. Fewer copies may be acceptable with the ENGINEER’s approval.
3. Provide complete information required by the Contract Documents, including the maintenance summary form. Include tabbed section placeholders for testing, startup and commissioning, and As-Built information.
4. Disposition: As specified in SECTION 01 33 00.
5. If accepted:
   a. One copy will be returned to the CONTRACTOR.
   b. One copy will be forwarded to the CPM.
   c. One copy will be retained in the ENGINEER's file.
6. If rejected:
   a. Two copies will be returned to the CONTRACTOR with the ENGINEER's comments for revision.
   b. One copy will be retained in the ENGINEER's file.
   c. Resubmit three revised preliminary copies for the ENGINEER's review.

D. Final O&M Manuals:

1. Submit four copies of the final O&M manual within 40 days after the commissioning of specific equipment but before final completion. Final O&M manuals shall be submitted and approved before final completion.
2. If final O&M manuals are acceptable, the CONTRACTOR will be notified.
3. If rejected, and at the ENGINEER's option:
   a. Three copies will be returned to the CONTRACTOR for revision.
   b. One copy will be retained by the ENGINEER and necessary revision data will be requested from the CONTRACTOR.
   c. Resubmit four revised copies for the ENGINEER’s review.

E. O&M Manuals for Equipment and Systems:

1. Preliminary O&M manuals:
   a. Submit a minimum of 60 days prior to the installation of equipment, system, subsystem, or component.
   b. Include a copy of the warranties, bonds, and service agreements when specified.
   c. Partial payments will not be made for equipment and systems unless preliminary O&M manuals are acceptable to the ENGINEER as specified in SECTION 01 29 00.
2. Final O&M manuals: Submit a minimum of 60 days prior to equipment or system field testing or startup.

F. O&M Manuals for Materials and Finishes:

1. Preliminary O&M manuals: Submit a minimum of 15 days prior to the request for final inspection.
2. Final O&M manuals: Submit within 10 days after the final inspection.

G. Maintenance Summary Forms:

1. Provide completed forms 60 days prior to installation for mechanical and electrical equipment and systems installed as part of the preliminary O&M manual. Also, provide forms in the final O&M manual.
2. Provide in the same sequence as the product data.
3. Provide immediately following the table of contents.

H. Forms for optional CONTRACTOR use: The following forms can be found online in DW’s CPPM: http://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual/.

1. Facility startup evaluation.
2. Equipment startup requirements.
3. Maintenance summary.
4. Manufacturer’s certificate of proper installation.
5. Manufacturer’s instruction certification.

1.3 QUALITY ASSURANCE

A. General:

1. Furnish for each item of equipment or system as specified in individual Specification Sections, and any further requested information. Provide O&M manuals in both hardcopy and electronic formats.
2. Prepare data for use by the OWNER’s personnel in the form of an instructional manual and on electronic media.

3. Hardcopy manual format:
   a. Size: Drawings 11 inches by 17 inches, other documentation 8 1/2 inches by 11 inches.
   b. Paper: 20 lb minimum, white.
   c. Text: Manufacturer's printed data or neatly typewritten.
   d. Punch data, three-hole, for binding and composition. Arrange the printing so that punched holes do not obliterate data.
4. Provide a fly-leaf for each separate product, or each piece of operating equipment, with a typed description of the product and the major component parts of the equipment and provide heavy section dividers with numbered plastic index tabs, fully indexed with permanent numbered tabbed section dividers and sequentially numbered pages. Section dividers with slide in paper tabs will not be accepted.
   a. Provide each manual with a title page and a typed table of contents with consecutive page numbers. Place the contents of the entire set, identified by volume number, in each binder.
   b. Cover: Identify each volume with the typed or printed title “Operation and Maintenance Manual, Volume No. [__] of [__]” when applicable. List the following:
      1) The Project title.
      2) Designate the system or equipment for which it is intended.
      3) The identity of separate structure as applicable.
      4) The identity of general subject matter covered in the manual.
      5) The identity of the equipment number and the Specification Section.
   c. Binders shall be labeled on ends/binds with a minimum of Submittal number, Specification Section, description, type of submittal and date.
   d. Assemble and bind material in the same order as specified, as much as possible.
   e. Material shall be suitable for reproduction with quality equal to the original. The photocopying of material is acceptable except for material containing photographs.
   f. Binders:
      1) Preliminary manuals: Commercial quality, substantial, permanent, three-ring or three-post binders with durable, cleanable plastic.
      2) Final manuals: Commercial quality, substantial, permanent, three-ring or three-post binders with durable, cleanable plastic.
   g. A table of contents neatly typewritten and arranged in systematic order containing the following:
      1) The CONTRACTOR, name of responsible principal, address, and telephone number.
      2) A list of each product required to be included, indexed to the content of each volume.
      3) A list with each product: Name, address, and telephone number of Subcontractor, Supplier, Installer, and Maintenance Contractor, as appropriate:
         a) Identify the area of responsibility of each.
         b) Provide a local source of supply for parts and replacement.
      4) Identify each product by its product name and other identifying numbers or symbols as set forth in the Contract Documents.
   h. Complete itemized Bill of Material, including complete model number with options. The Bill of Material shall be after the submittal table of contents.
   i. Product data:
      1) Include only those sheets pertinent to the specific product.
      2) Clearly annotate each sheet to:
         a) Identify the specific product or part installed.
         b) Identify the data applicable to installation.
         c) Delete references to inapplicable information.
   j. Drawings: Supplement product data with Drawings as necessary to illustrate:
      1) Relations of component parts of equipment and systems.
      2) Control and flow diagrams.
      3) Coordinate Drawings with Record Documents to ensure the correct illustration of completed installation.
      4) Do not use Record Documents as maintenance manual drawings.
      5) Provide a reinforced punched binder tab; bind in with text.
      6) Folded, 11 inches by 17 inches, identifying the Specification Section and product on the Drawings and envelopes.
   k. Instructions and procedures: Within the text, as required to supplement the product data:
      1) Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwise be required.
      2) Organize in a consistent format under a separate heading for each different procedure.
      3) Provide a logical sequence of instructions for each procedure.
      4) Provide an information sheet for the ENGINEER’s personnel, including:
         a) Proper procedures in the event of failure.
         b) Instances that might affect the validity of warranties or bonds.
   l. Warranties, bonds, and service agreements: As specified in SECTION 01 77 00.
5. Electronic manual format:
   a. Compatible with 64-bit version of Windows 7 or newer operating system and Adobe Acrobat.
   b. Bookmarked with index, chapter, and subchapter or index, division, and subdivision layout.

c. Electronic manuals, including Supplier and Manufacturer manuals, shall be submitted in searchable PDF format.
d. The electronic format shall contain the same text, diagrams, drawings, and cut sheets that the hardcopy versions contain on compact disc(s).

B. O&M Manuals for Equipment and Systems:
1. Manuals for equipment and systems shall be prepared by the Equipment Manufacturer or system Supplier.
2. Content for each unit or common units and systems:
a. Description of unit and component parts including controls, accessories, and appurtenances:
1) Function, normal operating characteristics, and limiting conditions.
2) Performance curves, engineering data, nameplate data, and tests.
3) Complete nomenclature and commercial number of replaceable parts.
b. Operating procedures:
1) Startup, break-in, routine, and normal operating instructions.
2) Test procedures and the results of factory tests where required.
3) Regulation, control, stopping, and emergency instructions.
4) Description of operation sequence by the Control Manufacturer.
5) Shutdown instructions for both short and extended durations.
6) Summer and winter operating instructions, as applicable.
7) Safety precautions.
8) Special operating instructions.
c. Maintenance and overhaul procedures:
1) Routine operations.
2) Guide to troubleshooting.
3) Disassembly, removal, repair, reinstallation, and reassembly.
d. Installation instructions: Including alignment, adjusting, calibrating, and checking.
e. Original Manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list and diagrams required for maintenance.
f. Spare parts ordering instructions.
g. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, and terminals).
h. Manufacturer's printed operating and maintenance instructions.
i. As-installed, color-coded piping diagrams.
j. Charts of valve tag numbers with the location and function of each valve.
3. Maintenance summary:
a. Compile an individual maintenance summary form for each applicable equipment item, respective unit, or system, and for components or subunits.
b. Format:
1) Use the required maintenance summary form.
2) Each maintenance summary may take as many pages as required.
3) Use only 8 1/2 inch by 11 inch paper.
4) Complete the form using a typewriter or electronic printing.
c. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend the type, grade, and temperature range of the lubricants and the frequency of lubrication.
d. Include pertinent maintenance data necessary for the full and proper maintenance and operation of the item or system.
e. Recommended spare parts:
1) Data shall be consistent with the Manufacturer's Bill of Materials/Parts List furnished in the O&M manuals.
2) Unit is the unit of measure for ordering part.
3) Quantity is the number of units recommended.
4) Unit cost is the current purchase price.
4. Content for each electric or electronic item or system:
a. Description of unit and component parts:
1) Function, normal operating characteristics, and limiting conditions.
2) Performance curves, engineering data, nameplate data, and tests.
3) Complete nomenclature and commercial number of replaceable parts.
4) Interconnection wiring diagrams, including control and lighting systems.
b. Circuit directories of panelboards:
1) Electrical service.
2) Controls.
3) Communications.
c. A list of electrical relay settings and control and alarm contact settings.
d. An electrical interconnection wiring diagram including control and lighting systems.
e. As-installed control diagrams by the Control Manufacturer.
f. Maintenance procedures:
1) Routine operations.
2) A guide to troubleshooting.
3) Adjustment and checking.

4) A list of relay settings and control and alarm contact settings.
g. Manufacturer's O&M instructions.

C. O&M Manuals for Materials and Finishes:
1. Content for architectural products, applied materials, and finishes:
a. Manufacturer's data, giving full information on products:
1) Catalog number, size, and composition.
2) Color and texture designations.
3) Information required for reordering special-manufactured products.
b. Instructions for care and maintenance:
1) Manufacturer's recommendation for types of cleaning agents and methods.
2) Cautions against cleaning agents and methods detrimental to the product.
3) Recommended schedule for cleaning and maintenance.
2. Content for moisture protection and weather exposed products:
a. Manufacturer's data, giving full information on products:
1) Applicable standards.
2) Chemical composition.
3) Details of installation.
b. Instructions for inspections, maintenance, and repair.

1.4 WARRANTY

A. O&M Manual for Warranties:
1. General: Include a master index and a section for each Warranty specified by the Specification Section.
2. Section content: Manufacturer's warranty data, giving full information on the type, term, actual warranty, contact information, and inclusions and exclusions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 91 00.01
COMMISSIONING (FOR COMPLEX PROJECTS)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for commissioning.

B. Related Sections:

1. SECTION 01 29 00 – PAYMENT PROCEDURES
2. SECTION 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION
3. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
4. SECTION 01 45 00 – QUALITY CONTROL
5. SECTION 01 77 00 – CLOSEOUT PROCEDURES
6. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
7. SECTION 23 09 00 – HVAC CONTROLS
8. SECTION 40 50 00 – INSTRUMENTATION AND CONTROL SYSTEMS

1.2 DEFINITIONS

A. Certificate of Proper Installation: A DW form signed by the authorized representative(s) and the Commissioning Manager to confirm that the supplied equipment is ready for operation and further testing.

B. Commissioning: The phase in a Project starting after Manufacturer equipment services (certificate of proper installation) and ending before startup. Commissioning activities consist of the completion of the facility commissioning procedures. This includes, but is not limited to, Phase 1 ORT, Phase 2 ORT, and PAT.

C. Commissioning Manager: The CONTRACTOR Representative in responsible charge of the commissioning and startup phase of the construction Project.

D. Electrical Commissioning: Activities necessary to ensure electrical equipment is operational, complies with industry and Manufacturer's requirements, and it is suitable for energization.

E. Facility: The entire Project or a portion thereof including unit processes.

F. Facility Commissioning and Startup Plan (FCS plan): The guiding document that defines the overall plan and sequencing for the facility commissioning and startup effort. This plan is composed of two separate plans, a commissioning plan and a startup plan.

G. Facility Commissioning and Startup Procedures (FCS procedures): The step-by-step activities necessary to test, verify, demonstrate, document, and evaluate that individual equipment, unit processes, or systems operate, function, and perform as required by the Contract Documents. The FCS procedures include two separate sets of procedures, one set for commissioning, and one set for startup. Following execution of the FCS procedures, the CONTRACTOR's final submission and the ENGINEER approval will validate the OWNER's final acceptance and be a prerequisite to Substantial Completion.

H. FDT: A test performed by the Manufacturer, at the Manufacturer's facilities, to verify or demonstrate that equipment, systems, or products meet functional, performance, or other specified requirements. This test is witnessed by the ENGINEER. FDT may be replaced with SDT at the site if approved by the ENGINEER.

I. Individual Unit Process Tests: Tests performed as part of the startup phase to demonstrate a 5-day continuous operation on an individual item of equipment, system, or unit process.

J. Manufacturer's Services: Includes activities performed by the Manufacturer's Representative to ensure proper equipment installation and conformance with the Supplier's specified requirements.

K. PAT: A test to demonstrate equipment and systems performance and modes of operation as specified in the Contract Documents. These tests occur after Phase 2 ORT and complete the commissioning portion of the facility commissioning procedures. They are a prerequisite for startup.

L. Phase 1 ORT: A series of tests and inspections performed by the CONTRACTOR to verify, demonstrate, and document that mechanical, electrical, and process equipment and the I&C system are ready for operation prior to the ENGINEER witnessing Phase 2 ORT.

M. Phase 2 ORT: Consists of a repeat of the tests, inspections, verifications, demonstrations, and documentation included in Phase 1 ORT; witnessed by the ENGINEER.

N. SDT: A test performed by the Manufacturer, at the site, to verify or demonstrate that equipment, systems, or products meet functional, performance, or other specified requirements. This test is witnessed by the ENGINEER. FDT may be replaced with SDT at the site if approved by the ENGINEER.

O. Startup: The phase in a Project starting after the commissioning phase that ends with full facility operation. Startup activities consist of demonstrating continuous operation of each unit process and the complete facility. Startup includes a coordinated effort between the CONTRACTOR, the Subcontractors, the Manufacturers, the ENGINEER and the OWNER.

P. Typical Commissioning and Startup Activity Relationship Chart: A graphical representation of the allotted durations and time relationships between the activities and events included in the typical commissioning and startup activity sequence; shown in Supplement A.

Q. Typical Commissioning and Startup Activity Sequence: A tabular list of contractual events and commissioning and startup activities showing the order or sequence that the activities or events typically occur in during a Project. The list includes some of the related contractual constraints, time relationships between activities or events, and contractual references to the constraints and timing requirements. For less complex or short duration projects, time periods or relationships may require an adjustment to occur within the actual Contract duration. Reduction or adjustment of these time periods shall be approved by the ENGINEER. A typical commissioning and startup activity sequence is shown in Supplement B.

R. UFT: A test of equipment, systems, instrumentation, and controls to verify they are functional, operational, and meet performance requirements. This preliminary test shall simulate the FDT and be performed by the CONTRACTOR without the ENGINEER'S observation.
S. Unit Process: The portion of a facility that performs a specific process function, such as a clarification process or a filtration process, and is composed of a set of specific functional equipment.
T. Water Management Plan: A part of the FCS plan that identifies activities necessary to obtain required permits, coordinate interactions with the OWNER, discharge points of test water, and estimate quantities of test water to ensure water management required for testing.

1.3 SUBMITTALS

A. Commissioning and Startup Activity Relationships:
1. Submit a Project specific commissioning and startup activity relationship chart that identifies the proposed time periods between the various activities.
a. Submit within 5 days of the CLS.
2. An example of a typical commissioning and startup activity relationship chart detailing activity sequencing and required time periods is shown in Supplement B.
3. For less complex or short duration projects, time periods or relationships may require adjustment to occur within the actual contract duration. Reduction or adjustment of the time periods shall be approved by the ENGINEER.
4. Coordinate and integrate the activities and activity updates with the monthly submittal of the CLS.

B. QC Submittals:
1. Provide a qualified Commissioning Manager for multi-discipline projects, including but not limited to pump stations, vaults, treatment plants, electrical, and hydro. The Commissioning Manager's sole responsibility shall be to coordinate, monitor, and manage the FCS requirements specified in this Section and other contract documents. The CONTRACTOR's superintendent or project manager may not act as the Commissioning Manager.
2. Commissioning Manager qualifications:
a. Submit within 60 days of the Notice to Proceed.
b. Submit with or prior to the preliminary facility commissioning and startup plan.
c. Experience on at least five separate projects similar in size and scope to this Project with the role of managing the startup and commissioning of process, mechanical, electrical, instrumentation, HVAC, and piping systems, or a total of 5 years of experience.
d. Include a narrative of Project specific duties, responsibilities, and site participation.
3. Hire a Commissioning Manager from a third-party if the submitted individual fails to meet the qualifications and the OWNER does not approve the submission.

C. Administrative Submittals:
1. Submittal timing:
a. Facility Commissioning and Startup Plan: Submit within 60 days after receiving the Notice to Proceed. Obtain the ENGINEER's approval of the plan within 120 days after receiving the Notice to Proceed.
b. Facility Commissioning and Startup Procedures: Submit 90 days prior of the start of commissioning. Obtain the ENGINEER's approval of the procedures 45 days prior to the start of commissioning.
c. Facility Commissioning and Startup Record: Completed documentation shall be submitted 30 days prior to the Final Completion date. The record Submittal shall include completed documentation of the commissioning and startup tests and forms.
2. Facility Commissioning and Startup Plan:
a. The FCS plan is composed of two separate plans: A commissioning plan and a facility startup plan.
b. For each plan include, at a minimum or as approved by the ENGINEER, the following:
1) A table of contents and an outline, a summary level breakdown listing individual unit processes or systems detailing the integration into a complete facility commissioning and startup plan.
2) A narrative describing safety during commissioning and startup activities.
3) Roles and responsibilities of commissioning and startup team members.
4) Narratives describing the commissioning plan and startup activities and methodology that includes a list of equipment, devices, or systems that shall be commissioned and started up.
5) A list of constraints or issues to be addressed during the plan development.
6) Prerequisite activities such as commissioning and energization of electrical systems, completion of Manufacturers services, pipe testing, labeling of equipment, control devices and conductors, and other activities as necessary.
7) A step-by-step activity sequence and schedule for each plan integrated with existing facility operation constraints and I&C system testing as specified in SECTION 40 50 00. Include activities for each facility commissioning procedure.
8) A list and schedule of connections to existing facilities, such as piping, conduits, electrical, or control systems.
9) For each commissioning or startup activity, prepare a schedule of OWNER involvement or participation for coordination of required OWNER Work tasks, QA testing, biological testing, and other required testing, witnessing, or inspections. This schedule to provide necessary information to coordinate dates, times, type of OWNER support, and activities or tasks to be performed by the OWNER to integrate with the commissioning and startup plans.
10) Contingency plans for operation of critical equipment or systems during commissioning and startup.

11) A water management plan that identifies the water needs, timing, and methods of delivery and disposal for coordination with the OWNER.

3. Facility Commissioning and Startup Procedures:
   a. The FCS procedures are composed of two separate sets of procedures: A set of commissioning procedures and a set of facility startup procedures.
   b. The commissioning procedures are composed of Phase 1 ORT, Phase 2 ORT, and the PAT for each piece of equipment or groups of equipment that comprise a system.
   c. The FCS procedures shall be a three-ring binder that also includes forms, certifications, certificates of proper installation, etc. in a draft form that shall be used for the following tests:
      1) The commissioning procedures shall include, at a minimum or as approved by the ENGINEER, the following:
         a) Phase 1 ORT which is a series of tests and verifications performed by the CONTRACTOR to confirm and demonstrate that the equipment or systems are ready for operation and test witnessing by the ENGINEER in the Phase 2 ORT. The Phase 1 ORT includes the tests, verifications, and documentation of the following activities:
            (1) Prerequisite activities such as commissioning of electrical systems and grounding systems, completion of factory and site demonstration tests, as specified in individual specifications, and verification of the Manufacturer's certificate of proper installation.
            (2) Provide a signed draft of the certificate of proper installation to the ENGINEER prior to proceeding with equipment commissioning and further startup of the equipment. Include the executed and signed certificates of proper installation in the facility commissioning and startup record.
            (3) Verification of installation and testing of piping, piping connections, piping support system, process monitoring indicators, mechanical, and electrical safety devices and systems.
            (4) Verification that piping and other equipment have been properly disinfected prior to interconnecting them with existing facilities.
            (5) Verification that equipment models provided match the approved equipment Submittals.
            (6) Verification that equipment is properly lubricated prior to operation.
            (7) Verification by the CONTRACTOR and documentation that the equipment has been installed as recommended by the Manufacturer, if Manufacturer's services are not required.
            (8) Verification of proper installation, calibration, operation of primary monitoring devices, or systems.
            (9) Confirmation of proper mechanical and control equipment labeling, conductor labeling, conduit labeling, and process monitoring or control device labeling. These confirmations including the updating of As-Built Drawings, conduit and conductor schedule, and nameplate schedules.
            (10) Point-to-point testing of power and control circuits to verify installation matches the approved I&C drawings. Documentation of the point-to-point testing includes a highlighted set of control drawings indicating the circuits successfully tested and those still to be tested.
            (11) Develop step-by-step procedures, tests, and verifications necessary to demonstrate the proper operation and control of each piece of equipment or system. The procedures shall include mechanical, electrical, monitoring, and control testing activities. The procedures shall be developed from P&IDs, equipment specifications, and control strategies and organized in accordance with the approved outline described in the FCS plan. Software generated control and monitoring tests shall be included in the Phase 1 ORT procedures but may not be performed until the Phase 2 ORT; however, hardwired control devices and associated control strategies shall be tested in the Phase 1 ORT procedures. The test format shall be cause and effect and include a method of evaluating the test results. The tester initiates an input which is the cause. The equipment or system reacts to the input and produces an effect. If the effect produced agrees with the proper or anticipated effect, the test is considered successful. Documentation of the test results shall be recorded on a spreadsheet type, tabular form with a column for the CONTRACTOR to sign off that the specific test or verification has been performed, when it was performed, and by whom. This Phase 1 ORT spreadsheet may include a column for ENGINEER witnessing and sign-off and be used to for Phase 2 ORT testing results.
            (12) Prepare an I/O test record including interfaces with the PLC system on an ENGINEER-approved I/O test record. Update the list as testing progresses to document testing of each input or output. Phase 1 ORT I/O testing only needs to verify that the proper signal or signal response is received at the PLC I/O status lights on the PLC cards. Phase 2 ORT needs to verify that the proper signal or response is received or transmitted by the PLC to test, verify, and document PLC programming.
               (a) Wherever possible, develop and perform tests using actual process variables, equipment, and data. If not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define simulation techniques in test procedures.
            (13) Prepare and periodically update a single Project-wide list of mechanical, electrical power, and control device settings or setpoints. This list includes mechanical devices such as pressure relief system settings, on/off setpoints, and other control settings of control switches and monitoring devices, alarms, interlocks, permissives, protective, trip checks, and overload devices.
            (14) Additional information related to I&C system testing requirements as specified in SECTION 40 50 00.

(15) Additional information related to HVAC control system testing requirements as specified in SECTION 23 09 00.

b) Phase 2 ORT is a series of tests and verifications performed by the CONTRACTOR to verify and demonstrate that the equipment or systems are ready for operation. This series of tests are witnessed by the ENGINEER. Phase 2 ORT includes a repeat of the Phase 1 ORT activities, tests, and verification except they are witnessed and verified by the ENGINEER. The ENGINEER will actively participate in many of the tests and reserves the right to test or retest specified functions whether or not explicitly stated in the test procedures.
   (1) In additional to the Phase 1 ORT activities, Phase 2 ORT activities shall include:
      (a) Approved preliminary O&M shall be on-site and available for reference by the ENGINEER and the commissioning team.
      (b) Complete PLC system I/O test record including confirmation by OWNER Personnel that the PLC receives the inputs and provides necessary outputs.
      (c) Perform software generated control and monitoring tests and repeat testing of hardwired control devices and related control strategies. Schedule 10 days for OWNER or third-party application software testing during commissioning activities per system.
      (d) Perform other tests as required by the ENGINEER based on the results and observations developed during Phase 1 ORT.
      (e) Other requirements related to I&C system testing requirements as specified in SECTION 40 50 00.

c) The PAT shall be developed to demonstrate equipment and systems performance and the modes of operation as specified in the Contract Documents. These tests typically occur after Phase 2 ORT and complete the commissioning portion of the facility commissioning and startup procedures.
   (1) The PAT shall include tests and procedures designed to verify and demonstrate that individual equipment or systems meet or exceed the specified performance requirements of the individual specifications.
   (2) The test procedures shall incorporate tests and verifications necessary to demonstrate and evaluate that the equipment or systems meet physical performance requirements such as capacity, vibration, and other capabilities. In addition to the physical performance requirements, the test procedures shall fully demonstrate that I&C are performing as specified in P&IDs, equipment specifications, and control descriptions.
   (3) Based on the type of performance test being demonstrated and the facility operational constraints, the PATs may be performed in conjunction with the Phase 2 ORT or the facility startup if approved by the ENGINEER.

2) The startup procedures are composed of activities verifying proper operation of a system or facility. The startup procedures shall include, at a minimum or as approved by the ENGINEER, the following:
   a) A sequence of logical steps necessary to place the entire facility in operation. Develop the startup procedures, in conjunction with the ENGINEER and the OWNER's Operations Personnel, detailing step-by-step instructions for the startup of each unit process and the complete facility. Include a schedule outlining the date when each step or related procedures shall be performed.
   b) Detailed activities and tasks required to perform each of the startup procedures. For each activity or task include a description of the unit process being started, unit process startup procedures (e.g., valves to be open/closed, order of equipment startup, etc.), required water, power, chemicals, etc. needed for startup, facilities operations interface, and OWNER involvement, including the type of OWNER assistance and the number of OWNER Personnel required.
   c) In addition to activities and tasks required to demonstrate normal continuous operation, develop and include tests that create or simulate abnormal or emergency operation conditions such as random equipment failures, tank overflows, surcharges, and bypasses to confirm alarm and/or shutoff requirements.
   d) The startup procedures shall include a test period(s) to demonstrate that each unit process and ultimately the entirety of the facility is capable of properly operating for a continuous period of time. For each unit process, the system or equipment shall be operated for 5 days, without significant interruption, to demonstrate successful continuous operation on an individual unit or a set of unit processes. Where unit processes rely on other equipment or systems, the contributing equipment or systems shall be operated for 5 days to demonstrate continuous operation prior to proceeding with the 5-day unit process testing.

4. The Facility Commissioning and Startup record shall include the following:
   a. The approved facility commissioning and startup plans.
   b. The approved facility commissioning and startup procedures as executed with the tests, records, and documentation described as follows:
      1) Documentation of the results of the ORT1, ORT2, PAT, 5-day continuous operation tests, and other commissioning activities performed.
      2) Test documentation shall include the ENGINEER's signature acknowledging witnessing of the tests or verifications.

D. Forms for optional CONTRACTOR use: The following forms can be found online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual.
   1. Manufacturer's certificate of proper installation.
   2. Equipment startup requirements.
   3. Maintenance summary.
   4. PLC I/O testing record.

1.4 QUALITY ASSURANCE

A. CONTRACTOR Facility Commissioning and Startup Responsibilities:
   1. General:
      a. Facilitate and attend facility commissioning and startup meetings with the ENGINEER and the OWNER to discuss and develop testing plans and procedures.
      b. Develop and submit the facility commissioning and startup plan and the facility commissioning and startup procedures.
      c. Perform Work for the tests specified including existing equipment as appropriate as outlined in the facility commissioning and startup plan, the facility commissioning and startup procedures, and the equipment specifications.
      d. Demonstrate proper installation, adjustment, function, performance, and operation of equipment.

B. OWNER/ENGINEER Facility Commissioning and Startup Responsibilities:
   1. General:
      a. Attend facility commissioning and startup meetings with the CONTRACTOR and provide input to assist the CONTRACTOR with the development of testing plans and procedures.
      b. Review the CONTRACTOR's test plans, procedures, and schedule.
      c. Witness Phase 2 ORTs and PATs.
      d. Coordinate other OWNER operations, if necessary, to facilitate the CONTRACTOR's tests.
      e. Provide PLC/RTU and computer software support if applicable and specified.
      f. Provide water, power, and other items as specified for testing.
   2. Facility startup period: Operate process units and devices with the support of the CONTRACTOR.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. The Commissioning Manager shall manage the commissioning and startup activities of the Project.
   1. Duties and responsibilities:
      a. Coordinate and expedite testing and facility startup.
      b. Develop a facility commissioning and startup plan and schedule setting forth the sequence of testing and commissioning required.
      c. Facilitate and conduct the facility commissioning and startup meetings specified in the Contract Documents. Manage Work during commissioning and startup and the performance evaluation time frames to document problems and ensure they are corrected as soon as practical, including during night-shift hours.
      d. Manage and supervise commissioning and startup activities on-site.
      e. Complete and document the FCS procedures and submit the FCS procedures record.
      f. Respond to questions regarding initial operation of the facility.

3.2 STARTUP

A. Commissioning:
   1. General:
      a. Complete Work associated with each unit and related processes before testing, including related Manufacturer's Representative services.
      b. Furnish qualified Manufacturer's Representatives to assist in testing, as appropriate, in the individual Specification Sections.
      c. Prior to commissioning, verify that the certificate of proper installation form has been provided by the Commissioning Manager to certify the equipment has been installed in accordance with the Manufacturer's recommendations; has been inspected, calibrated, and adjusted, as applicable; the electrical and mechanical connections meet quality and safety standards; and applicable safety equipment has been properly installed and tested. Provide a signed draft copy of the certificate of proper installation prior to proceeding with further commissioning and startup. In the case of electrical equipment, multiple representatives may need to sign the certification. A signed draft copy of the electrical equipment's certificate of proper installation shall be provided prior to energization of any downstream electrical equipment.
      d. Schedule commissioning and facility startup meetings to discuss the test schedule, plan of test, materials, chemicals, and liquids required, facilities operations interface, and OWNER involvement, including the type of OWNER assistance and the number of OWNER Personnel required.
      e. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment required to conduct testing.
      f. In conjunction with the ENGINEER, develop a water management plan as part of the facility commissioning and startup plan to determine required permits, discharge points of test water, and estimated quantities of test water.
      g. Verify cleaning and perform checks prior to beginning ORT testing:
         1) Calibrate testing equipment in accordance with the Manufacturer's instructions.

2) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
3) Lubricate equipment in accordance with the Manufacturer's instructions.
4) Turn rotating equipment by hand when possible to confirm equipment is not bound.
5) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6) Check the power supply to electric-powered equipment for the correct voltage and phase orientation and rotation using a bump test.
7) Adjust clearances and torque.
8) Test piping for leaks.

2. Commissioning period:
   a. ORTs – Phase 1 ORT and Phase 2 ORT:
      1) Conduct facility commissioning and startup procedures.
      2) Notify the ENGINEER and the Manufacturer's Representative in writing at least 14 days prior to the scheduled date of testing.
      3) The test includes, but is not limited to, inspecting I&C for proper fabrication, installation, point to point testing of circuits, calibration and adjustment on loop-by-loop, circuit-by-circuit, component-by-component basis, and verification that PLC I/O signals are operational.
      4) Verify modes of operation perform as intended.
      5) Verify safety devices, permissives, interlocks, trips, and other functions react as intended and operate properly.
      6) Verify unit processes or equipment meet the ORT requirements specified, such equipment will be accepted for the purposes of advancing to the performance testing phase.
   b. PAT:
      1) Obtain approval from the ENGINEER that ORT requirements have been satisfied prior to beginning performance testing.
      2) Conduct tests to demonstrate physical performance requirements are achieved and that control systems operate as required by the P&IDs, individual specifications, control descriptions, and OWNER provided programming.
      3) Some PATs may be conducted as part of the startup of a facility, as appropriate, and as approved by the ENGINEER.
      4) Notify the ENGINEER in writing at least 14 days prior to the scheduled date of the test.
      5) Follow the approved testing plan and detailed procedures specified.
      6) Use source and type of fluid, gas, or solid for testing as specified.
      7) Provide labor, materials, and supplies for conducting the test and, if applicable, for collecting samples and performance measurements.
      8) Obtain written approval from the ENGINEER that equipment meets the performance requirements specified prior to advancing to facility startup.

B. Startup:
   1. General:
      a. The intent of startup testing is for the CONTRACTOR to demonstrate to the OWNER and the ENGINEER that Work will function as a complete and operable system under normal and emergency operating conditions and is ready for acceptance.
      b. Coordinate, manage, and supervise the facility startup procedures in conjunction with the ENGINEER and the OWNER's Operations Personnel and direct the startup of each unit process and the complete facility.
      c. Support the OWNER's Operations Personnel throughout the facility startup period.
      d. For computer subsystem applications software programming being furnished by the OWNER, coordinate with the OWNER's Programming Personnel for startup assistance.
      e. Sequence each unit process to a point where the complete facility is operational for the evaluation of the unit process and facility operation.
      f. Demonstrate the proper operation of required interfaces within and between individual unit processes to the ENGINEER's satisfaction.
      g. Provide adequate, on-call, Subcontractor and Equipment Manufacturer Personnel to prevent delays.
      h. Schedule ongoing Work so as not to interfere with or delay completion of the facility startup. Do not schedule or perform non-commissioning activities in the same areas where the commissioning team is working.
      i. As approved by the ENGINEER and after the facility is operating, complete performance testing of the systems or items of equipment not previously tested.
      j. Maintain the facility, assuming a 24 hour day, 7 day per week operation, beginning at startup.
   2. Startup period:
      a. Manage startup activities, coordinate designated plant operating personnel and Work, and ensure various modes of operation are tested and complete. Testing shall include operation during average and peak daily flows, random equipment failures, tank overflows, surcharges, bypass operations, and any other operations needed to verify system requirement compliance.
      b. Where possible, verify test results using visual confirmation of process equipment and actual process variables. Exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. If approved by the ENGINEER, test verification by means of

disconnecting wires or measuring signal levels shall be acceptable only where the direct operation of equipment is not possible.

c. Where incremental startup is required, the sequencing of unit processes shall be in accordance with the construction sequencing and constraints specified in the Contract Documents, or as otherwise chosen by the CONTRACTOR and approved by the ENGINEER.

d. Make equipment adjustments, repairs, and corrections necessary to complete facility startup.

e. Incremental startup of individual unit processes shall be considered complete when, in the opinion of the ENGINEER, the unit process or a designated portion thereof has operated in the manner intended for 5 continuous days without significant interruption, unless the time period is specifically changed by the ENGINEER. This period is in addition to any training, functional, or performance test periods specified elsewhere.

f. In addition to any incremental startup of individual unit processes, demonstrate the entire facility operates in the manner intended for 5 continuous days without significant interruption. This period is in addition to any incremental individual unit process startup periods and any training, functional, or performance test periods specified elsewhere.

g. Significant interruption may include any of following events:
   1) The failure to provide and maintain qualified on-site startup personnel as scheduled.
   2) The failure to meet specified performance for more than 2 consecutive hours.
   3) The failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours of the failure.
   4) The failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours of the failure.
   5) The consistent or repeated failure of specified performance, critical equipment or unit process, and noncritical equipment or unit process. Consistent or repeated failure is defined as more than three occurrences.

h. Significant interruption will require that the startup in progress be stopped and restarted from time zero after corrections are made.

i. Acceptability of the facility startup will be based on the documented test results and verifications in the facility commissioning and startup record.

3. Post-startup period:

a. After the facilities have been successfully started up and placed into service, the entire system shall be subject to an I&C acceptance test as specified in SECTION 40 50 00. To complete the requirement, the I&C and PLC/RTU communications shall operate properly, without significant system malfunction, as deemed by the ENGINEER, for a continuous uninterrupted time period of 20 days. The 20-day test shall be an activity listed in the CLS.

b. The I&C acceptance test will be facilitated and monitored by the ENGINEER and the OWNER with the support of the CONTRACTOR. The CONTRACTOR will be notified if any portion of the system fails to operate properly.

c. If the I&C system fails to meet the requirement, make the necessary repairs or adjustments required to correct the problem. The acceptance test shall be completely restarted from the beginning for a complete retest.

3.3 SUPPLEMENTS

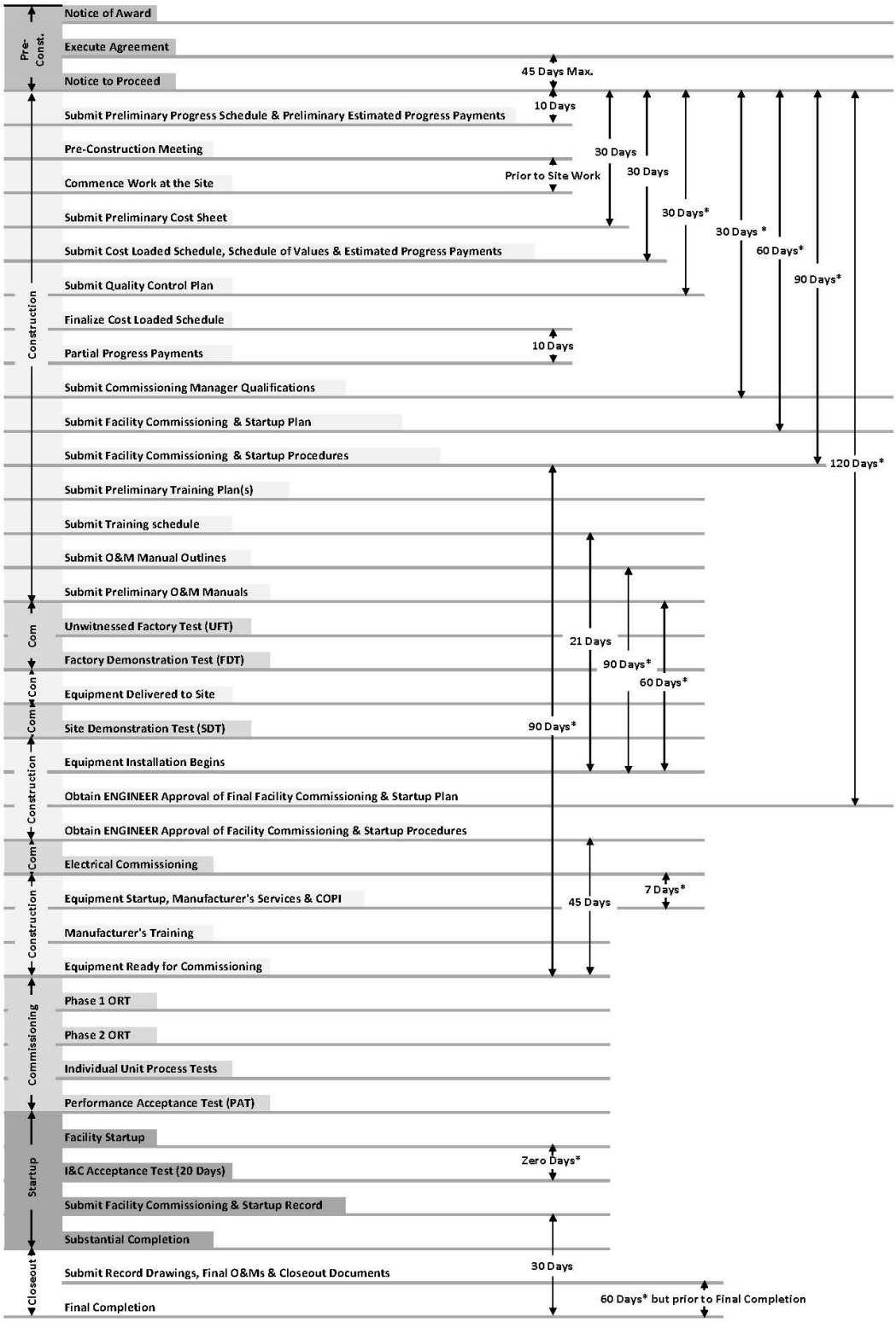
A. Supplement A – Typical Commissioning and Startup Activity Relationships

B. Supplement B – Typical Commissioning and Startup Activity Sequence

END OF SECTION

INTENTIONALLY BLANK

Supplement A - Typical Commissioning and Startup Activity Relationships



Note: 1) An asterisk following a time period (*) indicates, that for less complex or short duration projects, time periods or relationships may require adjustment to occur within the actual contract duration. Reduction or adjustment of these time periods shall be approved by the ENGINEER

INTENTIONALLY BLANK

SUPPLEMENT B
TYPICAL COMMISSIONING AND STARTUP ACTIVITY SEQUENCE

Project Phase	Activity or Event	General Description	Partial List of Activity Constraints or Requirements	Section Reference(s)
Pre-Construction	Notice of Award	The written notice by the OWNER to the apparent successful bidder of the award of the Contract.	Once accepted by the CONTRACTOR, the OWNER will sign and deliver the Agreement to the CONTRACTOR.	General Conditions
	Execute Agreement	Completion of the written agreement between the OWNER and the CONTRACTOR that covers the Work to be performed.	Bonds and Certificates of Insurance shall be furnished with the executed Agreement.	General Conditions
	Notice to Proceed	A written notice provided by the OWNER to the CONTRACTOR that fixes the date on which the Contract Time will begin.	A Notice to Proceed may be given at any time within 45 days after the Effective Date of the Agreement.	General Conditions
Construction	Preliminary Progress Schedule	Details those activities that will take place during the first 30 days after the Pre-Construction Meeting and prior to submittal of the CLS.	1) Submit schedule and other required documents within 10 days after the date of the Notice to Proceed. 2) On-site Work may be prohibited until submission and approval of this schedule by the ENGINEER.	1) 01 32 16 (.01 or .02) 2) General Conditions
	Pre-Construction Meeting	A meeting to discuss administration and communication procedures and to establish a working understanding between the parties as to the Work.	Pre-Construction Meeting shall be held prior to the CONTRACTOR proceeding with Work at the site.	General Conditions
	Commence Work At Site	The CONTRACTOR begins performing Work at the site.	Pre-Construction Meeting shall be held prior to the CONTRACTOR proceeding with Work at the site.	General Conditions
	Preliminary Cost Sheet	Shall indicate the predicted change order pricing including labor rates and burdens, equipment rates, markups, overhead and profit, and insurance and bond costs.	Submit within 30 days after the date of the Notice to Proceed.	General Conditions
	CLS	A detailed schedule of individual activities required to complete the Work and the associated cost that the CONTRACTOR anticipates requesting partial payment for as the Work is progressively completed.	1) Submit within 30 days after the date of the Notice to Proceed or as specified in the Contract Documents. 2) Meet to finalize CLS 10 days prior to the first application for partial payments. 3) Progress payments cannot be made until CLS is reviewed by the ENGINEER.	1) General Conditions 01 32 16 (.01 or .02) 2) General Conditions 3) 01 32 16 (.01 or .02)
	Construction Schedule of Values	Allocates values for the various parts of the Work used as the basis for submitting and reviewing progress payments. Synonymous with schedule of values.	1) Submit with CLS. 2) Submit within 30 days after the date of the Notice to Proceed.	1&2) 01 32 16 (.01 or .02)
	Estimated Progress Payments	A list of the estimated amount of each progress payment for each pay period. The estimated progress payments are also known as cash flow projections.	1) Submit Estimated Progress Payments with CLS within 30 days of Notice to Proceed. 2) Update adjustments with Partial Progress Payment Applications (more complex projects). 3) Submit preliminary estimated progress payments with the preliminary progress schedule within 10 days after the Notice to Proceed. 4) Update the cash flow projections on a quarterly basis (less complex projects).	1 & 2) 01 29 00 3) 01 32 16 (.01 or .02) 4) 01 32 16 (.01 or .02)

Construction	Partial Progress Payments	Period payments made to the CONTRACTOR based upon the quantity of Work performed and completed during the payment period.	1) Submit by 20th of each month. 2) The partial payment application shall be accompanied by evidence of the OWNER's title to the material and equipment and evidence of sufficient insurance. 3) Necessary documentation includes updated CLS, cost and narrative progress reports, and construction photographs. 4) Obtain the ENGINEER'S approval of the current status of As-Builts prior to submitting each request for progress payment. 5) Partial payments will not be made for equipment and systems unless preliminary manuals are acceptable to the ENGINEER.	1 & 2) General Conditions 3) 01 32 16 (.01 or .02) 3 & 4) 01 32 00 5) 01 78 23
	QC Plan	A strategic set of procedures consisting of the administrative and procedural requirements and the testing and monitoring activities to evaluate the quality of a product or service and confirm they meet the requirements the Contract Documents.	1) Submit within 30 days of the Notice to Proceed.	1) 01 45 00
	Commissioning Manager Qualifications	Submittal of qualifications.	1) Submit within 30 days of the Notice to Proceed. 2) The Commissioning Manager shall have experience on at least five separate water related projects managing the startup and commissioning of process, mechanical, electrical, instrumentation, HVAC, and piping systems.	1 & 2) 01 91 00
	FCS Plan	The guiding document that defines the overall plan and sequencing for the facility commissioning and startup effort; composed of a commissioning plan and a startup plan.	Submit plan within 60 days after Notice to Proceed.	01 91 00
	FCS Procedures	The step-by-step activities necessary to test, verify, evaluate, document and demonstrate that individual equipment, unit processes or systems operate, function and perform as required by the Contract Documents. The FCS procedures include two separate sets of procedures, one plan for commissioning and one plan for startup.	Submitted within 90 days of commissioning start may be submitted with the preliminary facility commissioning and startup plan.	01 91 00
	Training Schedule	The schedule for training sessions.	Submit a minimum of 21 days prior to the start of equipment installation.	01 43 33
	O&M Manual Outlines	Detailed outline of individual Supplier O&M manuals.	Submit 90 days prior to the start of equipment installation.	01 78 23
Construction	Preliminary O&M Manuals	Submittal of individual preliminary Supplier O&M manuals.	1) CLS values for both the Preliminary O&M and the final O&M values shall be 5% each of the sum of the total equipment cost and the installation cost of the equipment or system. 2) Submit 60 days prior to equipment installation.	1) 01 32 16 (.01 or .02) 2) 01 78 23

Commissioning	UFT	A test of equipment, systems, instrumentation, and controls to verify they are functional, operational, and meet performance requirements. This preliminary test shall simulate the FDT; it is performed by the CONTRACTOR without the ENGINEER'S observation.	Verify I&C functionality and performance.	01 91 00 40 50 00
	FDT	A test performed by the Manufacturer, at the Manufacturer's facilities, to verify or demonstrate that equipment, systems, or products meet functional, performance, or other specified requirements. This test is witnessed by the ENGINEER. FDT may be replaced with SDT at the site if approved by ENGINEER.	For power, instrumentation, and controls, test components and circuits, with exception of primary elements and final control elements, to demonstrate they are functional, operational, and meet the Contract requirements. For equipment or unit processes: Test equipment, permissives, interlocks, and integral controls to demonstrate they are functional, operational, and meet the contract requirements. Demonstrate performance as specified in the individual equipment or system specifications.	01 91 00 40 50 00
Construction	Equipment Delivered to Site	Equipment is delivered to the site and installation may proceed.	Preliminary O&M manuals shall be acceptable to ENGINEER prior to payment for equipment	01 78 23
Commissioning	SDT	This test is performed on-site and replaces the FDT if an FDT is not performed.	The SDT shall include the tests and verifications required by the FDT; it is witnessed by the ENGINEER.	40 50 00
Construction	Equipment Installation	Installation of equipment begins.		
	Facility Commissioning and Startup Plan Approval	See preliminary FCS Plan.	Obtain the ENGINEER's approval of the plan within 120 days after receiving the Notice to Proceed.	01 91 00
	Facility Commissioning and Startup Procedures Approval	See preliminary FCS Procedures.	Obtain the ENGINEER's approval of the procedures 45 days prior to the start of commissioning.	01 91 00
Commissioning	Electrical Commissioning and Certificate of Proper Installation	Activities necessary to ensure electrical equipment is operational and complies with industry and Manufacturer requirements and is suitable for energization.	A signed draft copy of the electrical equipment's certificate of proper installation shall be provided 7 days prior to energization of any downstream electrical equipment.	01 91 00
Construction	Manufacturer's Services and Certificate of Proper Installation	Manufacturer's Services include activities performed by the Manufacturer's Representative to ensure proper equipment installation and conformance with the Supplier's specified requirements.		01 43 00 01 91 00
	Manufacturer's Training	Specified training provided by Manufacturers.		01 43 00
	Equipment Ready for Commissioning	Equipment installation has progressed to the commissioning phase.		

Commissioning	Phase 1 ORT	A series of tests and inspections performed by the CONTRACTOR to verify, demonstrate, and document that mechanical, electrical, and process equipment and the I&C system are ready for operation prior to the ENGINEER witnessing Phase 2 ORT.		01 91 00 40 50 00
	Phase 2 ORT	Consists of a repeat of the tests, inspections, verifications, demonstrations, and documentation as Phase 1 ORT; witnessed by the ENGINEER.		01 91 00 40 50 00
	Individual Unit Process Operational Tests	Individual unit processes shall operate without significant interruption.	Incremental startup of individual unit processes shall be operated in the manner intended for 5 continuous days without significant interruption.	01 91 00
	PAT	A test to demonstrate equipment and systems performance; may include the modes of operation as specified in the Contract Documents. These tests occur after Phase 2 ORT and complete the commissioning portion of the facility commissioning procedures; a prerequisite for startup.		01 91 00 40 50 00
Startup	Facility Startup	Entire facility is sequentially placed into service.	In addition to any incremental startup of individual unit processes, demonstrate that the entire facility operates in the manner intended for 5 continuous days without significant interruption.	01 91 00 40 50 00
	I&C Acceptance Test	I&C system operational and reliability test.	After the I&C has been completely installed and made operational, the entire system shall be subject to an operational test run before being accepted. The I&C and PLC/RTU communications shall operate properly, without significant system malfunction for a continuous uninterrupted time period of 20 days.	40 50 00
	Substantial Completion	The Work (or a specified part thereof) has progressed to the point where it is sufficiently complete in the opinion of the ENGINEER. It is sufficiently complete, in accordance with the Contract Documents, so the Work (or specified part) can be utilized for the purpose for which it is intended.		1) General Conditions
Close Out	Submit Facility Commissioning and Startup Record	Provide electrical, instrumentation, and Drawings annotated with actual as-constructed details.	Submit 30 days prior to the Final Completion date.	01 91 00
	Record Drawings and Final O&M Manual Submitted	Provide Final O&M manuals and As-Builts of electrical, instrumentation, and Drawings for review and approval of the ENGINEER.	Within 60 days after the Substantial Completion date and prior to the Final Completion date.	01 78 23 01 77 00
	Closeout Documents Submitted	In addition to Record Drawings and Final O&M Manuals, Submit Warranties, Bonds, Service Agreements, Releases of Liens, Claims and Agreements and Spare Parts.	Within 60 days after the Substantial Completion date and prior to the Final Completion date.	01 77 00 01 78 23
	Final Completion	All submittals and documents for Contract Closeout approved.		01 77 00

Note: **1) For less complex or short duration projects, time periods or relationships may require adjustment to occur within the actual contract duration. Reduction or adjustment of these time periods shall be approved by the ENGINEER.**

SECTION 01 91 00.02
COMMISSIONING (FOR LESS-COMPLEX PROJECTS)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for commissioning.

B. Related Sections:

1. SECTION 23 09 00 – HVAC CONTROLS
2. SECTION 40 50 00 – INSTRUMENTATION AND CONTROL SYSTEMS

1.2 DEFINITIONS

A. Certificate of Proper Installation: A DW form signed by the authorized representative(s) and the Commissioning Manager to confirm that the supplied equipment is ready for operation and further testing.

B. Commissioning: The phase in a Project starting after Manufacturer equipment services (certificate of proper installation) and ending before startup. Commissioning activities consist of the completion of the facility commissioning procedures.

C. Commissioning Manager: The CONTRACTOR Representative in responsible charge of the commissioning and startup phase of the construction Project.

D. Electrical Commissioning: Activities necessary to ensure electrical equipment is operational, complies with industry and Manufacturer's requirements, and it is suitable for energization.

E. Facility: The entire Project or a portion thereof including unit processes.

F. Facility Commissioning and Startup Plan (FCS plan): The guiding document that defines the overall plan and sequencing for the facility commissioning and startup effort.

G. Facility Commissioning and Startup Procedures (FCS procedures): The step-by-step activities necessary to test, verify, demonstrate, document, and evaluate that individual equipment, unit processes, or systems operate, function, and perform as required by the Contract Documents.

H. Individual Unit Process Tests: Tests performed as part of the startup phase to demonstrate a 5-day continuous operation on an individual item of equipment, system, or unit process.

I. Manufacturer’s Services: Includes activities performed by the Manufacturer’s Representative to ensure proper equipment installation and conformance with the Supplier’s specified requirements.

J. ORT: A series of tests and inspections performed by the CONTRACTOR to verify, demonstrate, and document that mechanical, electrical, and process equipment and the I&C system are reading for operation prior to the ENGINEER witnessing PAT.

K. PAT: A test to demonstrate equipment and systems performance and modes of operation as specified in the Contract Documents.

L. Startup: The phase in a Project starting after the commissioning phase that ends with full facility operation. Startup activities consist of demonstrating continuous operation of each unit process and the complete facility. Startup includes a coordinated effort between the CONTRACTOR, the Subcontractors, the Manufacturers, the ENGINEER and the OWNER.

M. Typical Commissioning and Startup Activity Relationship Chart: A graphical representation of the allotted durations and time relationships between the activities and events included in the typical commissioning and startup activity sequence.

N. Typical Commissioning and Startup Activity Sequence: A tabular list of contractual events and commissioning and startup activities showing the order or sequence that the activities or events typically occur in during a Project.

O. UFT: A test of equipment, systems, instrumentation, and controls to verify they are functional, operational, and meet performance requirements before startup occurs. This preliminary test shall be performed by the CONTRACTOR without the ENGINEER'S observation.

P. Unit Process: The portion of a facility that performs a specific process function, such as a clarification process or a filtration process, and is composed of a set of specific functional equipment.

Q. Water Management Plan: A part of the FCS plan that identifies activities necessary to obtain required permits, coordinate interactions with the OWNER, discharge points of test water, and estimate quantities of test water to ensure water management required for testing.

1.3 SUBMITTALS

A. Commissioning and Startup Activity Relationships:

1. Submit a Project specific commissioning and startup activity relationship chart that identifies the proposed time periods between the various activities.
   a. Submit at least 60 days prior of the start of commissioning. Obtain the ENGINEER’s approval of the procedures 30 days prior to the start of commissioning.
2. An example of a typical commissioning and startup activity relationship chart detailing activity sequencing and time periods is shown in Supplement A.
3. For less complex or short duration projects, time periods or relationships may require adjustment to occur within the actual contract duration. Reduction or adjustment of the time periods shall be approved by the ENGINEER.
4. Coordinate and integrate the activities and activity updates with the monthly submittal of the CLS.

B. QC Submittals:

1. Provide a qualified Commissioning Manager for multi-discipline projects, including but not limited to pump stations, vaults, treatment plants, electrical, and hydro. The Commissioning Manager’s sole responsibility shall be to coordinate, monitor, and manage the FCS requirements specified in this Section and other contract documents.
2. Commissioning Manager Qualifications:
   a. Submit within 60 days of the Notice to Proceed.
   b. Submit with or prior to the preliminary facility commissioning and startup plan.

c. The Commissioning Manager shall be someone other than the project manager or project superintendent, and shall have experience on at least five separate scope related projects managing the startup and commissioning of process, mechanical, electrical, instrumentation, HVAC, and piping systems, or a total of 5 years of experience.
d. Include a narrative of Project specific duties, responsibilities, and site participation.

3. Hire a Commissioning Manager from a third-party if the submitted individual fails to meet the qualifications and the OWNER does not approve the submission.

C. Administrative Submittals:

1. Facility Commissioning and Startup Plan:
   a. Submit at least 60 days prior of the start of commissioning. Obtain the ENGINEER's approval of the procedures 30 days prior to the start of commissioning. For each plan include, at a minimum or as approved by the ENGINEER, the following:
      1) A table of contents and an outline, a summary level breakdown listing individual unit processes or systems detailing the integration into a complete facility commissioning and startup plan.
      2) A narrative describing safety during commissioning and startup activities.
      3) Roles and responsibilities of commissioning and startup team members.
      4) Narratives describing the commissioning plan and startup activities and methodology that includes a list of equipment, devices, or systems that shall be commissioned and started up.
      5) A list of constraints or issues to be addressed during the plan development.
      6) Prerequisite activities and other activities as necessary.
      7) A step-by-step activity sequence and schedule for each plan integrated with existing facility operation constraints and I&C system testing as specified in SECTION 40 50 00. Include activities for each facility commissioning procedure.
      8) A list and schedule of connections to existing facilities, such as piping, conduits, electrical, or control systems.
      9) For each commissioning or startup activity, prepare a schedule of OWNER involvement or participation for coordination of required OWNER Work tasks.
      10) Contingency plans for operation of critical equipment or systems during commissioning and startup.
2. Facility Commissioning and Startup Procedures:
   a. The FCS procedures are composed of two separate sets of procedures: A set of commissioning procedures and a set of facility startup procedures:
      1) Prepare and periodically update a single Project-wide list of mechanical, electrical power, and control device settings or setpoints. This list includes mechanical devices such as pressure relief system settings, on/off setpoints, and other control settings of control switches and monitoring devices, alarms, interlocks, permissives, protective, trip checks, and overload devices.
      2) Additional information related to I&C system testing requirements as specified in SECTION 40 50 00.
      3) Additional information related to HVAC control system testing requirements as specified in SECTION 23 09 00.
         a) Approved preliminary O&M manuals for mechanical and electrical equipment and instruments shall be on-site and available for reference by the ENGINEER and the commissioning team.
         b) Complete PLC system I/O test record including confirmation by OWNER Personnel that the PLC receives the inputs and provides necessary outputs.
         c) Perform software generated control and monitoring tests and repeat testing of hardwired control devices and related control strategies.
         d) The PAT shall be developed to demonstrate equipment and systems performance and the modes of operation as specified in the Contract Documents.
            (1) Include tests and procedures designed to verify and demonstrate that individual equipment or systems meet or exceed the specified performance requirements of the individual specifications.
      4) The startup procedures are composed of activities verifying proper operation of a system or facility. The startup procedures shall include, at a minimum or as approved by the ENGINEER, the following:
         a) A sequence and schedule of logical steps necessary to place the entire facility in operation.
         b) Detailed activities and tasks required to perform each of the startup procedures.
         c) Tests that create or simulate abnormal or emergency operation conditions such as random equipment failures, tank overflows, surcharges, and bypasses to confirm alarm and/or shutoff requirements.
         d) Test period(s) to demonstrate that each unit process and ultimately the entirety of the facility is capable of properly operating for a continuous period of time. For each unit process, the system or equipment shall be operated for 5 days, without significant interruption, to demonstrate successful continuous operation on an individual unit or a set of unit processes. Where unit processes rely on other equipment or systems, the contributing equipment or systems shall be operated for 5 days to demonstrate continuous operation prior to proceeding with the 5-day unit process testing.
3. Facility Commissioning and Startup Record:
   a. Submit at least 30 days prior to Final Completion.
   b. The approved facility commissioning and startup plans.

c. The approved facility commissioning and startup procedures as executed with the tests, records, and documentation described as follows:
1) Documentation of the results of the PAT, 5-day continuous operation tests, and other commissioning activities performed.
2) Test documentation shall include the ENGINEER's signature acknowledging witnessing of the tests or verifications.

D. Forms for optional CONTRACTOR use: The following forms can be found online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual:.
1. Manufacturer's certificate of proper installation.
2. Equipment startup requirements.
3. Maintenance summary.
4. PLC I/O testing record.

1.4 QUALITY ASSURANCE

A. CONTRACTOR Facility Commissioning and Startup Responsibilities:
1. General:
a. Facilitate and attend facility biweekly commissioning and startup meetings with the ENGINEER and the OWNER to discuss and develop testing plans and procedures.
b. Develop and submit the facility commissioning and startup plan and the facility commissioning and startup procedures.
c. Perform Work for the tests specified including existing equipment as appropriate as outlined in the facility commissioning and startup plan, the facility commissioning and startup procedures, and the equipment specifications.
d. Demonstrate proper installation, adjustment, function, performance, and operation of equipment.

B. OWNER/ENGINEER Facility Commissioning and Startup Responsibilities:
1. General:
a. Attend facility commissioning and startup meetings with the CONTRACTOR and provide input to assist the CONTRACTOR with the development of testing plans and procedures.
b. Review the CONTRACTOR's test plans, procedures, and schedule.
c. Witness testing.
d. Coordinate other OWNER operations, if necessary, to facilitate the CONTRACTOR's tests.
e. Provide PLC/RTU and computer software support if applicable and specified.
f. Provide water, power, and other items as specified for testing.
2. Facility startup period: Operate process units and devices with the support of the CONTRACTOR.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. The Commissioning Manager shall manage the commissioning and startup activities of the Project.
1. Duties and responsibilities:
a. Coordinate and expedite testing and facility startup.
b. Develop a facility commissioning and startup plan and schedule setting forth the sequence of testing and commissioning required.
c. Facilitate and conduct the facility commissioning and startup meetings specified in the Contract Documents. Manage Work during commissioning and startup and the performance evaluation time frames to document problems and ensure they are corrected as soon as practical, including during night-shift hours.
d. Manage and supervise commissioning and startup activities on-site.
e. Complete and document the FCS procedures and submit the FCS procedures record.
f. Respond to questions regarding initial operation of the facility.

3.2 STARTUP

A. Commissioning:
1. General:
a. Complete Work associated with each unit and related processes before testing, including related Manufacturer's Representative services.
b. Ensure that Work by the CONTRACTOR and the Subcontractor is complete and fully integrated.
c. Furnish qualified Manufacturer's Representatives to assist in testing, as appropriate, in the individual Specification Sections.
d. Prior to commissioning, verify that the certificate of proper installation form has been provided by the Commissioning Manager.
e. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment required to conduct testing.
f. Verify cleaning and perform functional checks:
1) Calibrate testing equipment in accordance with the Manufacturer's instructions.
2) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
3) Lubricate equipment in accordance with the Manufacturer's instructions.
4) Turn rotating equipment by hand when possible to confirm equipment is not bound.

5) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6) Check the power supply to electric-powered equipment for the correct voltage and phase orientation and rotation using a bump test.
7) Adjust clearances and torque.
8) Test piping for leaks.

2. Commissioning period:
   a. Conduct facility commissioning and startup procedures.
   b. Notify the ENGINEER and the Manufacturer's Representative in writing at least 14 days prior to the scheduled date of testing.
   c. The test includes, but is not limited to, inspecting I&C for proper fabrication, installation, point to point testing of circuits, calibration and adjustment on loop-by-loop, circuit-by-circuit, component-by-component basis, and verification that PLC I/O signals are operational.
   d. Verify modes of operation perform as intended.
   e. Verify safety devices, permissives, interlocks, trips, and other functions react as intended and operate properly.
   f. Verify unit processes or equipment meet requirements specified, such equipment will be accepted for the purposes of advancing to the performance testing phase.
   g. Operational Readiness Testing (ORT):
      1) The test includes, but is not limited to, inspecting I&C for proper fabrication, installation, point to point testing of circuits, calibration and adjustment on loop-by-loop, circuit-by circuit, component by-component basis, and verification that PLC I/O signals are operation.
      2) Verify modes of operation perform as intended.
      3) Verify safety devices, permissives, interlocks, trips, and other functions react as intended and operated properly.
      4) Verify unit processes or equipment meet the ORT requirements specified, such that equipment will be accepted for the purposes of advancing to the performance testing phase.
      5) The ENGINEER shall have the option to witness loop testing. Provide 1-day notice to the ENGINEER of scheduled loop testing.
      6) Complete Testing and Balancing as part of ORT.
   h. Performance Acceptance Testing (PAT):
      1) Written results of successful ORT completion in its entirety shall be approved by the ENGINEER at least 1 day prior to the scheduled start of PAT.
      2) Obtain approval from the ENGINEER that requirements have been satisfied prior to beginning performance testing.
      3) Conduct tests to demonstrate physical performance requirements are achieved and that control systems operate as required by the P&IDs, individual specifications, control descriptions, and OWNER provided programming.
      4) Adjust control set points to simulate building load for the HVAC equipment. Allow equipment to cycle on and off for the duration of the startup period to verify system performance. For the duration of the startup period, document trended space temperatures, outdoor temperatures, units on/off durations, generated alarms, and other measurements and device conditions as necessary to demonstrate acceptable system and component performance. Separate startups shall be performed on the cooling and heating systems if outdoor temperatures do not allow for compliance with Manufacturer’s outdoor temperature instructions for operation of both at the same time.
      5) Obtain written approval from the ENGINEER that equipment meets the performance requirements specified prior to advancing to facility startup.

B. Startup:
   1. General:
      a. The intent of startup testing is for the CONTRACTOR to demonstrate to the OWNER and the ENGINEER that Work will function as a complete and operable system under normal and emergency operating conditions and is ready for acceptance.
      b. Coordinate, manage, and supervise the facility startup procedures in conjunction with the ENGINEER and the OWNER’s Operations Personnel and direct the startup of each unit process and the complete facility.
      c. Support the OWNER’s Operations Personnel throughout the facility startup period.
      d. Sequence each unit process to a point where the complete facility is operational for the evaluation of the unit process and facility operation.
      e. Demonstrate the proper operation of required interfaces within and between individual unit processes to the ENGINEER’s satisfaction.
      f. Provide adequate, on-call, Subcontractor and Equipment Manufacturer Personnel to prevent delays.
      g. Schedule ongoing Work so as not to interfere with or delay completion of the facility startup. Do not schedule or perform non-commissioning activities in the same areas where the commissioning team is working.
      h. As approved by the ENGINEER and after the facility is operating, complete performance testing of the systems or items of equipment not previously tested.
      i. Maintain the facility, assuming a 24 hour day, 7 day per week operation, beginning at startup.

2. Startup period:
    a. Manage startup activities, coordinate designated plant operating personnel and Work, and ensure various modes of operation are tested and complete. Testing shall include operation during average and peak performance requirements, random equipment failures, and any other operations needed to verify system requirement compliance.
    b. Where possible, verify test results using visual confirmation of process equipment and actual process variables. Exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality.
    c. Where incremental startup is required, the sequencing of unit processes shall be in accordance with the construction sequencing and constraints specified in the Contract Documents, or as otherwise chosen by the CONTRACTOR and approved by the ENGINEER.
    d. Make equipment adjustments, repairs, and corrections necessary to complete facility startup.
    e. Incremental startup of individual unit processes shall be considered complete when, in the opinion of the ENGINEER, the unit process or a designated portion thereof has operated in the manner intended for 5 continuous days without significant interruption, unless the time period is specifically changed by the ENGINEER. This period is in addition to any training, functional, or performance test periods specified elsewhere.
    f. In addition to any incremental startup of individual unit processes, demonstrate the entire facility operates in the manner intended for 5 continuous days without significant interruption. This period is in addition to any incremental individual unit process startup periods and any training, functional, or performance test periods specified elsewhere.
    g. Significant interruption may include any of following events:
        1) The failure to provide and maintain qualified on-site startup personnel as scheduled.
        2) The failure to meet specified performance for more than two consecutive hours.
        3) The failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours of the failure.
        4) The failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours of the failure.
        5) The consistent or repeated failure of specified performance, critical equipment or unit process, and noncritical equipment or unit process. Consistent or repeated failure is defined as more than three occurrences.
    h. Significant interruption will require that the startup in progress be stopped and restarted from time zero after corrections are made.
    i. Acceptability of the facility startup will be based on the documented test results and verifications in the facility commissioning and startup record.
    j. Post-startup period: After the facilities have been successfully started up and placed into service, the entire system shall be subject to an I&C acceptance test as specified in SECTION 40 50 00.

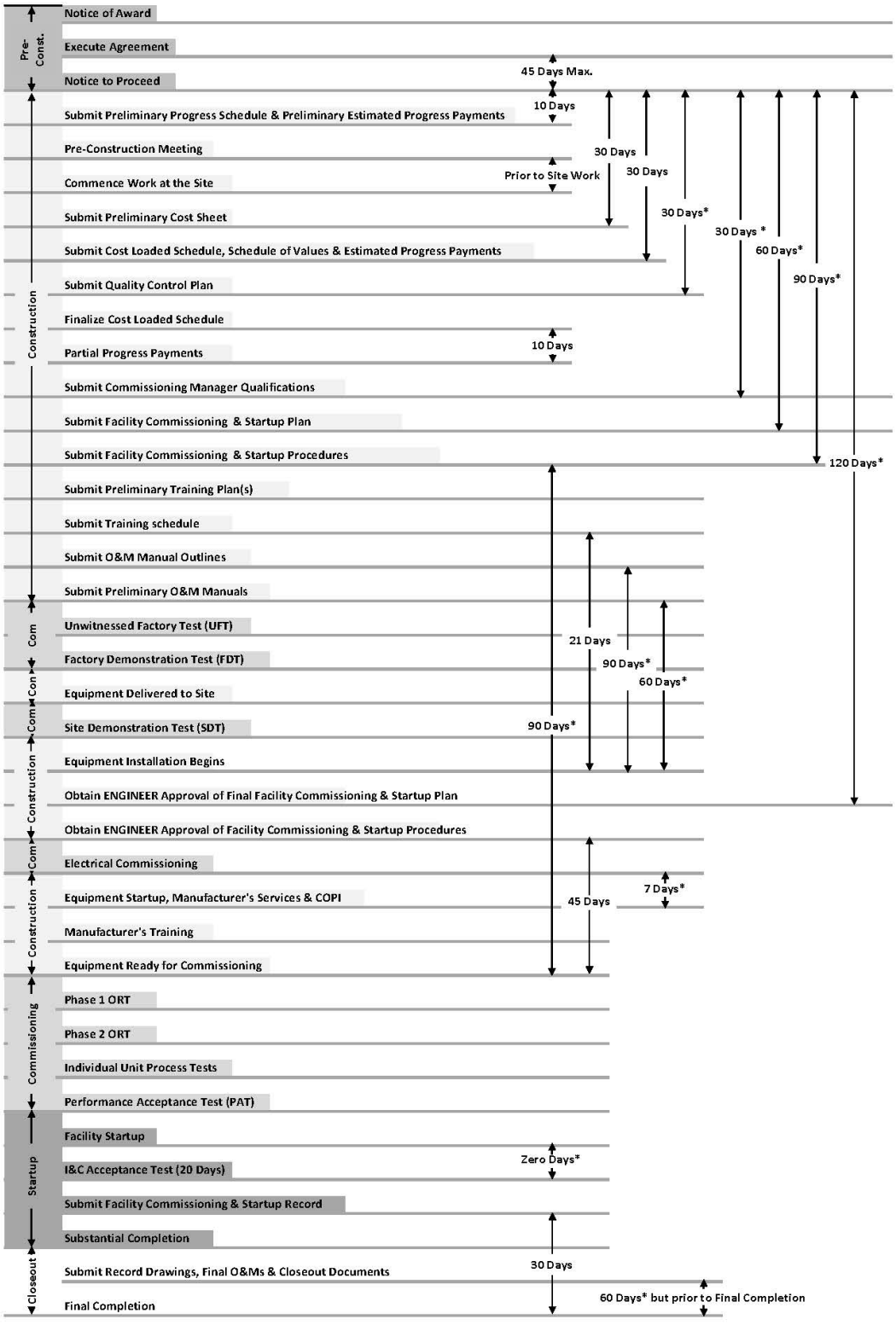
3.3 SUPPLEMENTS

A. Supplement A – Typical Commissioning and Startup Activity Relationships:
    1. NOTE – The following activity timelines may need to be adjusted to fit specific project milestones and shall be approved by the ENGINEER.

END OF SECTION

INTENTIONALLY BLANK

Supplement A - Typical Commissioning and Startup Activity Relationships



Note: 1) An asterisk following a time period (*) indicates, that for less complex or short duration projects, time periods or relationships may require adjustment to occur within the actual contract duration. Reduction or adjustment of these time periods shall be approved by the ENGINEER

INTENTIONALLY BLANK

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for selective demolition.

B. Related Sections:

1. SECTION 02 60 00 – ABATEMENT – ASBESTOS, LEAD PAINT, PCB OIL, PCB ELECTRICAL EQUIPMENT, AND OTHER HAZARDOUS MATERIALS
2. SECTION 03 62 00 – NON-SHRINK GROUTING
3. SECTION 31 23 23 – FILL

1.2 DEFINITIONS

A. Demolish, Demolition, or Remove: Remove and properly dispose of designated existing equipment, materials, and ancillary features and components.

B. Remove and Salvage: Remove and deliver existing equipment, materials, and ancillary features and components to the OWNER at a designated location.

C. Relocate: Remove and relocate existing equipment, materials, and ancillary features and components.

D. Reinstall: Make service connections and provide functional equipment at the designated new location.

E. Retain or Protect: Leave designated existing equipment, materials, and ancillary features and components in place and protect them from damage.

1.3 COORDINATION

A. Coordinate demolition with the ENGINEER.

1.4 SUBMITTALS

A. Quality Control Submittals:

1. Proposed methods of dustproof and weatherproof partitions and closures to be used.
2. Proposed methods of demolition and equipment to be used.
3. Copies of authorizations and permits required to perform demolition Work.
4. Hazardous materials disposal manifests.
5. CONTRACTOR-performed hazardous materials testing results.
6. CDPHE-approved Asbestos Abatement Contractor.
7. Lead Abatement Contractor.

1.5 SITE CONDITIONS

A. Information contained in the Contract Documents showing the scope of demolition is based on available Record Drawings:

1. Inspect facilities and verify the nature and location of the Work.
2. Differences between the Contract Documents and actual facilities do not constitute grounds for a time extension or Contract modifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Notify the ENGINEER in writing a minimum of 7 days prior to beginning demolition Work.

B. Provide temporary barricades and other protection as required.

C. Protect plant material affected by demolition activities.

D. Cover and protect existing facilities, structures, equipment, and fixtures.

E. Erect and maintain dustproof and weatherproof partitions and closures as required.

F. Provide required shoring, bracing, and supports.

G. Equipment and Materials Designated for Reuse:

1. Do not remove equipment or materials without the approval of the ENGINEER.
2. Store and maintain equipment and materials in the same condition as when removed.
3. The CONTRACTOR and the ENGINEER will document and record the condition of equipment and materials prior to removal.

H. Demolition:

1. Conduct demolition operations and debris removal in a manner ensuring minimum interference with roads, streets, and other adjacent occupied facilities currently in use.
2. Drawings define the extent of demolition. Only make rough cuts and breaks that exceed the limits of the demolition as shown on the Drawings if approved by the ENGINEER.
3. Remove materials to be in accordance with new elevations, profiles, and sizes. Comply with specified tolerances and finishes.
4. Saw cut or otherwise isolate materials to be removed to minimize damage to adjacent surfaces.
5. Remove concrete and asphalt in workable sections.
6. Remove piping from areas to be backfilled, as required. Pipe, valves, and fittings adjacent to those removed may also be removed as salvage.
7. Protect materials and equipment that are designated for reuse.
8. Remove items to be demolished to the limits as shown on Drawings.
9. Protect existing structures, components, and surfaces from damage.
10. Use water sprinkling, temporary enclosures, and other methods to limit dust.
11. Saw cutting:
    a. Cut openings in concrete structures with full-depth saw cut edges.

b. Core drill corners to prevent over-cutting.

12. Reinforcing steel:
    a. Cut reinforcing steel and the embedded material exposed by demolition flush with the concrete surface and coat exposed rebar with liquid epoxy.
    b. Repair the concrete surface with non-shrink grout as specified in SECTION 03 62 00.
13. Asbestos-cement pipe:
    a. Manage the materials in accordance with applicable federal, state, and local regulations.
    b. Reference SECTION 02 60 00 for field removal requirements.

I. Backfilling:
1. Backfill demolished areas to the existing ground level as specified in SECTION 31 23 23.
2. Do not use demolition debris as backfill material.

J. Salvage and Disposal:
1. Equipment and materials as shown on the Drawings to be removed shall be properly disposed of by the CONTRACTOR.
2. Salvage items identified as shown on the Drawings.
3. Dispose of demolished materials off-site in accordance with applicable laws, ordinances, rules, and regulations. Provide the original disposal manifest to the OWNER, when applicable.

END OF SECTION

SECTION 02 60 00
ABATEMENT – ASBESTOS, LEAD PAINT, PCB OIL,
PCB ELECTRICAL EQUIPMENT, AND OTHER HAZARDOUS MATERIALS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for abatement of asbestos, lead paint, PCB oil, PCB electrical equipment, and other hazardous materials.

1.2 REFERENCES

A. Colorado Department of Public Health and Environment (CDPHE):
   1. Regulation No. 8 – The Control of Hazardous Air Pollutants, Part B, The Control of Asbestos, 5 CCR 1001-10, Part B
   2. 6 CCR 1007-2 – Solid Waste Regulations

B. Environmental Protection Agency (EPA):
   1. Hazardous Materials Waste Program 49 CFR Part 105
   2. Resource Conservation and Recovery Act (RCRA) 40 CFR Parts 239 through 282
   3. Toxic Substances Control Act (TSCA) 40 CFR Part 761 – Polychlorinated Biphenyls (PCB) Regulations

C. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1926.1101 – Asbestos
   2. 29 CFR 1926.62 – Lead

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Asbestos Containing Materials:
   1. General procedures for flange gaskets, electrical conduit, asbestos-cement pipe, and other asbestos containing materials:
      a. Notify the ENGINEER in writing 1 day prior to the demolition of materials so the OWNER can be present.
      b. When asbestos is suspected or present, manage the materials in accordance with applicable federal, state, and local regulations including, but not limited to:
         1) OSHA 29 CFR 1926.1101.
         2) CDPHE Regulation No. 8.
         3) EPA Hazardous Materials Waste Program 49 CFR Part 105.
      c. Dispose of demolished materials off-site in accordance with applicable laws, ordinances, rules, and regulations.
      d. Provide the original disposal manifest to the OWNER, when applicable.
   2. Flange gaskets:
      a. Assume existing flange gaskets contain asbestos unless otherwise noted on the Drawings
      b. Gasket material disturbed during demolition shall be characterized regarding the presence of asbestos.
   3. Electrical conduit:
      a. The Drawings may indicate known locations of asbestos containing electrical conduit.
      b. Other electrical conduit containing asbestos may be present.
   4. Asbestos-cement pipe:
      a. When crossing abandoned pipe in conflict with new utilities, disconnect and remove asbestos-cement pipe at the nearest joint outside of the utility trench, and abandon remaining pipe in place. Removal shall be in accordance with applicable federal, state, and local regulations.
      b. When tying into existing pipe, disconnect asbestos-cement pipe at the nearest joint, remove remaining pipe in the utility trench to the next joint, and abandon remaining pipe in place. Removal shall be in accordance with applicable federal, state, and local regulations.

B. Lead Paint:
   1. Testing: Refer to the Contract Documents for the presence of lead paint.
   2. Hazard: Lead in paint has the potential to cause an inhalation hazard in the event the materials are disturbed (sanding, grinding, welding, or other means).
   3. Demolished materials:
      a. Paint removed from surfaces, paint chips, or associated dust may qualify as hazardous waste depending on the amount of lead present.
      b. Determine whether paint chips or other lead containing material shall mandate actions to maintain compliance with appropriate federal, state, and local environmental, health, and safety laws in accordance with EPA RCRA criteria.
      c. Manage materials uncovered during demolition that may contain lead in paint in accordance with applicable federal, state, and local regulations including, but not limited to:
         1) OSHA 29 CFR 1926.62.
         2) CDPHE 6 CCR 1007-2.
         3) EPA Hazardous Materials Waste Program 49 CFR Part 105.

C. PCB Oil and PCB Electrical Equipment:
   1. Testing: Refer to the Contract Documents for the presence of PCBs.

2. Handling: Handle and dispose of PCB containing material in accordance with applicable federal, state, and local regulations including, but not limited to:
    a. TSCA and the PCB regulations found at EPA TSCA 40 CFR Part 761.
    b. EPA Hazardous Materials Waste Program 49 CFR Part 105.

D. Other Hazardous Materials (Mercury Switches, Fluorescent Lighting, etc.):
1. Testing: Refer to the Contract Documents for the presence of mercury.
2. Handling:
    a. Manage materials uncovered during demolition that may contain other hazardous materials in accordance with applicable federal, state, and local regulations including, but not limited to:
        1) EPA RCRA 40 CFR Parts 239 through 282.
        2) EPA Hazardous Materials Waste Program 49 CFR Part 105.
        3) CDPHE 6 CCR 1007-2.
    b. Notify the ENGINEER in writing 1 day prior to the demolition of materials so the OWNER's Representative can be present.
    c. Provide the original disposal manifest to the OWNER.

END OF SECTION

SECTION 03 11 00
CONCRETE FORMING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for concrete forming.
- B. Related Sections:
  1. SECTION 01 40 00 – QUALITY REQUIREMENTS
  2. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 117 – Specification for Tolerances for Concrete Construction and Materials
  2. 301 – Specifications for Structural Concrete
  3. 318 – Building Code Requirements for Structural Concrete
- B. International Code Council (ICC):
  1. International Building Code (IBC), Chapter 17 – Special Inspections and Tests
- C. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. Form system, including form tie types.

1.4 QUALITY ASSURANCE
- A. System Design Requirements:
  1. Design formwork in accordance with ACI 301 and ACI 318 to provide concrete finishes as specified in SECTION 03 30 00.
  2. Custom, Project-specific formwork, tank wall and suspended slab formwork, falsework, and shoring designs shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
  3. Pre-engineered forming systems may be used.
  4. Make joints in forms mortar tight.
  5. Limit panel deflection to 1/360 of the span of each component span to achieve the tolerances specified.
  6. Unless otherwise specified, limit deflection of facing materials for concrete surfaces in accordance with ACI 301. Limit deflection of facing materials in accordance with tolerance limits established by Contract Documents and with tolerances required by the Equipment Manufacturers. Coordinate tolerance requirements with the Equipment Manufacturers.
  7. Components of the Work shall be in accordance with ACI 117.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Elastic Vinyl Plug:
  1. Dayton Superior Corporation, A-58 Sure Plug
- B. Form Release Agent:
  1. Dayton Superior, Magic Kote
  2. Unitex, Farm Fresh XL (certified NSF/ANSI 61)
- C. Structure Form Ties:
  1. Symons
- D. Wedge Inserts:
  1. Richmond Screw Anchor

2.2 MATERIALS
- A. Wall Forms and the Underside of Slabs and Beams: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce the specified finish and tolerances.
- B. Where steel forms are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.
- C. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.
- D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.
- E. All Other Forms: Materials as specified for wall forms.

2.3 ACCESSORIES
- A. Form Release Agent:
  1. Shall not bond with, stain, or adversely affect concrete surfaces.
  2. Shall not impair subsequent treatments of concrete surfaces when applied to forms.
  3. Use for concrete surfaces that will be in contact with potable water, stream, lake, and reservoir facilities.
  4. Non-toxic 30 days after application or certified to conform to NSF/ANSI 61.
- B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with the form surface, fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.
- C. Form Ties:
  1. Material: Steel.
  2. Spreader inserts:
     a. Conical or spherical type.
     b. Design to maintain positive contact with the forming material.

c. Provide units that will not leave metal closer than 1 inch to the concrete surface when forms, inserts, and tie ends are removed.
3. Tie wire form ties are not permitted.
4. Flat bar ties for panel forms; furnish plastic or rubber inserts with a minimum 1 inch depth and of sufficient dimensions to permit the patching of the tie hole.
5. Waterstop ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
   a. An integral steel waterstop that is 0.103 inch thick and 0.625 inch in diameter that is tightly and continuously welded to the tie.
   b. A neoprene waterstop that is 3/16 inch thick and 15/16 inch in diameter whose center hole is half the diameter of the tie or a molded plastic waterstop.
   c. A waterstop that is oriented perpendicular to the tie and symmetrical about center of the tie.
   d. Design ties to prevent the rotation or the disturbance of the center portion of the tie during the removal of ends and to prevent water leaking along the tie.
6. Through-bolts: Tapered and of a minimum 1 inch diameter at the smallest end.
7. Elastic vinyl plug: Design and size the plug to allow insertion with a tool to enable the plug to elongate and return to its original length and diameter upon removal to form a watertight seal.

PART 3 EXECUTION

3.1 PREPARATION

A. Thoroughly clean form surfaces in contact with concrete or existing concrete, dirt, and other surface contaminants prior to coating the surface.
B. Exposed Wood Forms in Contact with Concrete: Apply form sealer in accordance with the Sealer Material Manufacturer's instructions.
C. Steel Forms: Apply form sealer to steel forms as soon as they are cleaned to prevent the discoloration of concrete from rust.
D. Prior to placing reinforcing steel, coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Do not coat or allow form release to come in contact with hardened concrete against which fresh concrete is to be placed. Bond breaking materials or processes shall be used only after acceptance by the ENGINEER.
E. Carefully apply form oil to avoid contact with reinforcement steel. Embedded material, which becomes coated with form oil, shall be thoroughly cleaned or replaced at the expense of the CONTRACTOR.
F. Forms shall be recoated as required to facilitate removal and to prevent stripping damage to green concrete.

3.2 INSTALLATION

A. General:
   1. In accordance with ACI 301, unless otherwise specified.
   2. Design, erect, support, brace, and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure.
   3. Construct formwork so that concrete members and structures are of the correct size, shape, alignment, elevation, and position.
   4. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.
   5. Formwork shall be mortar-tight.
B. Beveled Edges (Chamfer):
   1. Form 3/4-inch bevels at exposed concrete edges unless otherwise shown on the Drawings.
   2. Where beveled edges on the existing adjacent structures are other than 3/4 inch, obtain the ENGINEER's approval of the size prior to placement of the beveled edge.
   3. Do not chamfer at concrete surfaces below brick or concrete masonry.
C. Wall Forms:
   1. Do not use forms with damaged surfaces.
   2. Where exposed to view, locate form ties and joints in an uninterrupted pattern for a smooth and uniform surface.
   3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.
D. Pavement Tolerances:
   1. Construct pavement in accordance with the permitting jurisdiction or the following tolerances; whichever is more stringent:
      a. Elevation: 3/4 inch.
      b. Thickness: +3/8 inch, -1/4 inch.
      c. Surface: In any direction, the gap below a 10 foot unleveled straight edge resting on high spots shall not exceed 1/2 inch.
      d. Joint reinforcement: Tie bars-alignment of tie bar end relative to line perpendicular to edge of pavement: 1/2 in/ft of tie bars.
      e. Dowels:
         1) Lateral alignment and spacing: 1 inch.
         2) Vertical alignment: 1/4 inch.
         3) Alignment of dowel bar end relative to line perpendicular to edge of pavement: 1/4 in/ft of dowel.
      f. Joint spacing:
         1) Contraction joint depth (slab thickness): +1/4 inch, 0 inch.
         2) Joint width: +1/8 inch, 0 inch.

E. Form Tolerances: Provide forms in accordance with ACI 117 and ACI 318.
   1. Wall finish tolerances:
      a. Straight vertical or horizontal wall surface: Flat planes within the tolerance specified.
      b. Wall Type W-A: Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high:
         1) Depressions in wall surface: Maximum 5/16 inch when 10-foot straight edge is placed on high points in all directions.
      c. Wall Type W-B: Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high:
         1) Depressions in wall surface: Maximum 1/8 inch when 10-foot straight edge is placed on high points in all directions.
      d. Thickness: +1/2 inch or -1/4 inch from the thickness shown on the Drawings.
   2. Slab finish tolerances:
      a. Exposed slab surfaces: Flat planes as required within the tolerances specified.
      b. Slab finish tolerances and slope tolerances: Crowns on the floor surface shall not be too high as to prevent 10-foot straight edge from resting on end blocks nor have low spots that allow a block of twice the tolerance in thickness to pass under a supported 10-foot straight edge.
      c. Slab Type S-A: Steel gauge block 5/16 inch thick.
      d. Slab Type S-B: Steel gauge block 1/8 inch thick.
      e. Slab Type S-A and S-B:
         1) Elevation: Slope slabs to the floor drain and gutter shall adequately drain regardless of tolerances.
         2) Thickness: +1/2 inch or -1/4 inch from the thickness shown on the Drawings, except where the thickness tolerance will not affect the slope, drainage, or slab elevation.
   3. Beam finish tolerances:
      a. Exposed straight horizontal and vertical surfaces: Flat planes within the tolerances specified.
      b. Beam Type B-A:
         1) Physical dimensions: +1/2 inch or -1/4 inch from the dimensions shown on the Drawings.
         2) Elevations: Within ±1/2 inch except where the tops of beams become part of the finished slab; in this case, refer to slab tolerances.

F. Removal:
   1. In accordance with ACI 318.
   2. Formwork not supporting the weight of concrete (e.g., sides of beams, walls, columns, and similar parts of Work) may be removed after cumulatively curing at not less than 50°F for 1 day after placing concrete, provided concrete is sufficiently hard enough to not be damaged by form removal operations and curing and protection operations are maintained.
   3. Remove forms in a manner that ensures the integrity of the structure and its surfaces.
   4. Withdrawal of form ties through the wall, column, or beam is not permitted.
   5. Form removal for elevated slabs or beams:
      a. Leave forms and shoring in place in accordance with ACI 318, Chapter 6, and until concrete has reached a compressive strength equal to 80% of specified 28-day compressive strength as determined by test cylinders, or 7 days.
      b. Concrete strength shall be 100% for any loading condition.
   6. Where applicable, forms shall not be removed until it has reached sufficient strength to withstand the forces generated by an embedded, swelling hydrophilic waterstop.

3.3 QUALITY CONTROL

A. Quality control, in accordance with ICC IBC, Chapter 17 requirements, is provided in Statement of Special Inspections Plan on the Drawings. The CONTRACTOR's responsibilities and related information as specified in SECTION 01 40 00.

B. Water Storage Elements: Tolerances are defined as allowable variations from specified alignments, grades, and dimensions. Allowable variations from specified alignments, grades, and dimensions as specified herein. Descriptions of these criteria as specified in this Section, and in accordance with ACI MCP15Pack and ACI 117.
   1. Walls:
      a. Vertical alignment:
         1) Variation from specified plumb: ≤3/8 inch, full wall height.
         2) Variation from specified plumb: ≤1/4 inch in 8 feet.
      b. Radius:
         1) Variation in radius in any 20 feet of wall length: ≤1/2 inch.
         2) Variation in radius in a segment: ≤ 1 inch.
      c. Grade top of wall: Variation from specified elevation: +1/4 inch, -1/4 inch.
      d. Thickness: Variation in design thickness: -0 inch, +1/4 inch.
   2. Openings:
      a. Floor slab, wall and roof slab openings:
         1) Radius: +1/8 inch, -1/8 inch.
         2) Location: Variation ±2 inches.
         3) Out of round: +1/8 inch, -1/8 inch.
         4) Cross-section, non-circular, dimensions: ≤ ±1 inch.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 15 00
CONCRETE ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for concrete accessories.

B. Related Sections:

1. SECTION 03 15 13 – POLYVINYL CHLORIDE WATERSTOP
2. SECTION 03 15 14 – THERMOPLASTIC ELASTOMERIC RUBBER WATERSTOP
3. SECTION 03 15 15 – HYDROPHILIC RUBBER WATERSTOP
4. SECTION 03 15 16 – CHEMICAL GROUT WATERSTOP
5. SECTION 03 21 00 – REINFORCING STEEL
6. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
7. SECTION 03 62 00 – NON-SHRINK GROUTING
8. SECTION 05 50 00 – METAL FABRICATIONS
9. SECTION 07 13 00 – SEALING SHEET WATERPROOFING
10. SECTION 07 16 00 – FLEXIBLE CEMENTITIOUS WATERPROOFING
11. SECTION 07 92 00 – JOINT SEALANTS
12. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. ASTM International (ASTM):

1. A 36 – Standard Specification for Carbon Structural Steel
2. A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
3. A 775 – Standard Specification for Epoxy Coated Steel Reinforcing Bars
4. D 226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
5. D 227 – Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
6. D 994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
7. D 1056 – Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber
8. D 1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer’s data sheets.
2. Installation instructions.

B. Shop Drawings:

1. Construction joints: Layout and location indicating the type of sealant to be used.
2. Location of elastomeric sealant for sloped and horizontal joints.

C. Quality Control Submittals:

1. Elastomeric sealant: The Manufacturer's instructions for product shipment, storage, handling, application, and repair.

1.4 QUALITY ASSURANCE

A. Components and Installation Procedures: In accordance with the Manufacturer's instructions.

B. Installer Qualifications:

1. A minimum of 3 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Work site in the Manufacturer's unpacked containers with labels intact and legible at the time of use.

B. Storage:

1. Store materials in a secure, indoor, dry area.
2. Maintain materials in a dry condition during delivery, storage, handling, installation, and concealment.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Pourable Joint Filler:

1. Sika Corporation, Sikaflex-2C

B. Waterstop Sealant:

1. Adeka Corporation, Adeka Ultraseal P-201

C. PE Joint Filler:

1. W.R. Meadows, Inc., Deck-O-Foam

2.2 MATERIALS

A. Bond Breaker:

1. Tape for expansion joints: Adhesive-backed glazed butyl or PE tape, the same width as the joint, which will adhere to the premolded joint material or concrete surface.
2. Use bond breaker tape or bond prevention material as specified in SECTION 03 30 00, except where tape is specifically required.

B. PE Joint Filler: PE closed-cell expansion joint filler.

C. Premolded Joint Filler:

1. Bituminous type: In accordance with ASTM D 994 or ASTM D 1751.

2. Sponge rubber: Neoprene, closed-cell, expanded; in accordance with ASTM D 1056, Type 2C5, with compression deflection, 25% deflection (limits), 17 psi to 25 psi minimum.

D. Pourable Joint Filler:
1. Self-leveling or non-sag as required for level, sloping, or vertical joints.
2. Use: Filler for water containment structures.
3. Products that will be in contact with potable water shall be certified to conform to NSF/ANSI 61.
4. Color: White.

E. Steel Expansion Joint Dowels:
1. Dowels: In accordance with ASTM A 36, round smooth steel bars.
2. Coating: As specified in SECTION 09 90 00, System 29A, with factory-applied lubricating coating.

2.3 ACCESSORIES

A. Joint Sealants: As specified in SECTION 07 92 00.
B. Waterstop sealant: Water-swelling, single-component elastic sealant.
C. Non-Shrink Grout: As specified in SECTION 03 62 00 and compatible with joint sealant.
D. Roofing Felt: In accordance with ASTM D 226, Type II, 30 lb asphalt-saturated or equal weight of ASTM D 227 coal-tar saturated felt.
E. Reinforcing Steel: As specified in SECTION 03 21 00.
F. PVC Waterstop: As specified in SECTION 03 15 13.
G. Hydrophillic Waterstop: As specified in SECTION 03 15 15.
H. Chemical Grout Waterstop: As specified in SECTION 03 15 16.
I. Sealing Strip Waterproofing Membrane: As specified in SECTION 07 13 00.
J. Flexible Cementitious Waterproofing: As specified in SECTION 07 16 00.
K. TPER Waterstop: As specified in SECTION 03 15 14.
L. Nails: As required for securing bituminous type premolded joint filler.
M. Masking Tape: As required to temporarily adhere to concrete at each side of the joint to receive filler.
N. Epoxy-Coated Rebar at Control Joints: In accordance with ASTM A 775 and ASTM A 615, Grade 60.
O. Wall Thimble: Fabricated as specified in SECTION 05 50 00.

PART 3 EXECUTION

3.1 GENERAL

A. Construct straight joints; make vertical or horizontal, except where walls intersect sloping floors.
B. Do not commence concrete placement until after joint preparation is complete.
C. The time between concrete placements shall be as specified in SECTION 03 30 00.
D. Construction joints not shown on the Drawings shall be approved by the ENGINEER and installed as specified in SECTION 03 30 00.

3.2 PREPARATION

A. Construction Joints:
1. Prior to the placement of abutting concrete, clean the contact surface.
2. Remove concrete laitance and spillage from reinforcing steel and dowels.
3. Roughen surface to a minimum of 1/4 inch amplitude to expose clean sound aggregate:
a. Sand blast after concrete has fully cured.
b. Water blast after concrete has partially cured.
c. Green cut fresh concrete with high-pressure water and hand tools.
4. Perform cleaning without damaging the waterstop, if one is present.
5. Surface preparation and product installation shall be in accordance with the Manufacturer’s recommendations.

3.3 INSTALLATION

A. Expansion Joint:
1. PE joint filler:
a. Examine concrete surfaces and correct surface imperfections that will prevent the proper installation and performance of filler.
b. Furnish joint filler in a single piece for the full depth and thickness required for the joint.
c. Make joints in the length of filler by butting two pieces together and fastening them securely with tape.
d. Secure filler in place to prevent displacement during and after concrete placement.
e. Do not use torn or irregular filler.
f. Tape the joint of multiple layers of filler (e.g., two 1-inch layers for a 2 inch wide joint) to prevent the intrusion of concrete between two layers of filler.
g. Install joint filler as recommended by the Manufacturer using the thickness of the filler shown on the Drawings (e.g., 1/4 inch, 3/8 inch, 1/2 inch, 3/4 inch, or 1 inch).
2. Premolded joint filler:
a. Sufficient in width to completely fill the joint space where shown on the Drawings.
b. If the waterstop is in a joint, cut a premolded joint filler to butt tightly against the waterstop and side forms.
c. Pre-cut, premolded joint filler to the required depth at locations where joint filler or sealant is to be applied.
d. Form cavities for joint filler with pre-cut, premolded joint filler or smooth, removable, accurately shaped material.
e. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface.
3. Bituminous type premolded joint filler:
a. Drive nails approximately 18 inches on center through filler prior to installing to provide anchorage embedment into the concrete during concrete placement.

b. Secure premolded joint filler in forms before concrete is placed.
c. Install in walkways, at changes in direction, at intersections, at each side of driveway entrances, and at 45 foot intervals, maximum.

4. Pourable joint filler:
   a. Form and remove the entire joint above the waterstop in slabs so that the entire space down to the waterstop can be filled with pourable joint filler.
   b. Install in accordance with the Manufacturer's instructions, except as specified herein:
      1) Fill the entire joint above the waterstop with joint filler as shown on the Drawings.
      2) Use masking tape on the top of slabs at the sides of joints; clean spillage and remove masking tape when installation is complete.
5. Steel expansion joint dowels:
   a. Install coated and lubricated bars parallel to the wall or slab surface and in true horizontal position perpendicular to the joint in both plan and section view.
   b. Secure dowels tightly in forms with rigid ties.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 15 04
ANCHORAGE AND BRACING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information and execution for anchorage and bracing.

B. Related Sections:

1. SECTION 01 40 00 – QUALITY REQUIREMENTS
2. SECTION 03 15 05 – ANCHORING TO CONCRETE
3. SECTION 05 12 00 – STRUCTURAL STEEL
4. SECTION 05 50 00 – METAL FABRICATIONS

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 318 – Building Code Requirements for Structural Concrete and Commentary

B. American Society of Civil Engineers (ASCE):

1. 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures

C. International Code Council (ICC):

1. International Building Code (IBC)

D. International Code Council Evaluation Service, Inc. (ICC-ES):

1. ESR – Evaluation Services Report

E. National Fire Protection Association (NFPA):

1. 13 – Standard for the Installation of Sprinkler Systems

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector, or others having statutory authority. AHJ may be the OWNER when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which the component importance factor is greater than 1.0.

1.4 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring CONTRACTOR-designed anchorage and bracing, unless specifically exempted.
   b. The Manufacturers engineered seismic and non-seismic hardware product data.
   c. Attachment assembly Drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. Seismic attachment assembly Drawings including connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or a components' final condition would require anchorage or bracing under this Section for new equipment.
   e. The Submittal will be rejected if the proposed anchorage method would create excessive stress to a supporting member. Revise anchorages and strengthen the structural support to eliminate the overstressed condition.

B. Informational Submittals:

1. Anchorage and bracing calculations for attachments, braces, and anchorages, include ICC IBC and Project-specific criteria as shown on the General Structural Notes on the Drawings, in addition to the Manufacturer's specific criteria used for design; prepared, stamped, and signed by a qualified Professional Engineer registered in the State of Colorado.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

1. Submitted seismic anchorage Drawings and calculations for designated seismic systems are identified as ICC IBC deferred Submittals and will be submitted to and shall be accepted by AHJ prior to the installation of the component, equipment, or distribution system.
2. Submit deferred action Submittals such as Shop Drawings with supporting deferred informational Submittals such as calculations no less than 4 weeks in advance of installation of the component, equipment, or distribution system to be anchored to the structure.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

A. Design and Performance Requirements:

1. Anchorage and bracing systems shall be designed by a qualified Professional Engineer registered in the State of Colorado.
2. Design anchorage into concrete including embedment depth in accordance with ACI 318, Appendix D (or other industry standard approved by the ENGINEER), and Project Specifications.
3. Unless otherwise shown on the Drawings, design for cracked concrete condition.
4. Design anchorage and bracing of architectural, mechanical, and electrical components and systems as specified in this Section, unless a design is specifically provided within the Contract Documents or where exempted hereinafter.

5. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for all applicable loading conditions including gravity, seismic, wind, operational, snow, ice, and temperature loading.
6. Anchor and brace piping and ductwork, whether exempt or not exempt for this Section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
7. Architectural components include, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
8. Provide supplementary framing where required to transfer anchorage and bracing loads to the structure.
9. Adjust equipment pad sizes as shown on the Drawings or provide additional anchorage confinement reinforcing to provide required anchorage capacities in terms of anchor distances to free concrete edges.
10. Design anchorage and bracing for the following:
    a. Equipment and components weighing more than 800 lbs and have center of mass located 4 feet or less above adjacent finished floor.
    b. Equipment weighing more than 75 lbs that have center of mass located more than 4 feet above adjacent finished floor.
    c. Mechanical and electrical components that are not provided with flexible connections between components and associated ductwork, piping, or conduit.
    d. Distribution systems that weigh more than 5 lbs/ft that have center of mass located more than 4 feet above adjacent finished floor.
11. Design seismic anchorage and bracing for designated seismic systems regardless of weight or mounting height.
    a. Component importance factor:
        1) Importance factor = 1.0, unless otherwise specified by the Manufacturer.
12. For components exempted from the design requirements of this Section, provide bolted, welded, or otherwise positively fastened attachments to the supporting structure.

B. Design Loads:
1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind. Exposed architectural components and exterior and wind-exposed mechanical and electrical equipment shall be as shown on the General Structural Notes on the Drawings. Alternately, Manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
    a. Design anchorage and bracing for loading supplied by the Equipment Manufacturer. The Equipment Manufacturer shall use ICC IBC required load cases in developing loads.
    b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
    c. Locate braces to minimize vibration to or movement of the structure.
    d. Vibratory loads:
        1) Use cast-in-place or adhesive anchors for vibrating loads as shown on the Drawings. Adhesive anchors with designated capacities for vibratory loading shall be used in accordance with the Manufacturer's ICC-ES ESR.
        2) Use slip-critical bolted connections as specified in SECTION 05 12 00 at bracing connections that are subject to vibrating loads.
4. Hydraulic: Design of anchorage for submerged gates and other mechanical equipment shall include hydrostatic and hydrodynamic loads in accordance with ASCE 7, Section 15.7.
5. Seismic:
    a. In accordance with ICC IBC, Section 1613 and ASCE 7, Chapter 13.
    b. Design anchorage and bracing for the criteria shown on the General Structural Notes on the Drawings.
    c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 as applicable for the project seismic design category.

C. Seismic Design Requirements:
1. Nonstructural components: Design as nonbuilding structures for components with weights greater than or equal to 25% of effective seismic weight of overall structure.
2. Local region of body of nonstructural component shall be capable of load transfer of anchorage attachment if component importance factor = 1.5.
3. The following are exempt from requirements for the provision of seismic anchorages and bracing, in addition to those items specifically exempted in ASCE 7, Part 13.5 for architectural components and Part 13.6 for electrical and mechanical equipment:
    a. Furniture, except storage cabinets and bookshelves over 6 feet tall.
    b. Temporary or movable equipment.
4. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet the requirements of ASCE 7, Chapter 13.
5. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
    a. Conduit diameter is greater than 2 1/2 inch trade size.
    b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 lbs/ft.
6. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new architectural, mechanical and electrical components, systems, or equipment.

D. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to the lateral force resisting system of the structure through a complete load path.
E. Design, provide, and install the overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.
F. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.
G. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.
    1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending of hangers and their attachments, unless high or limited deformability piping is used in accordance with ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 sf or weigh 17 lbs/ft or less.
H. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at the base and within 12 inches from the top of equipment, unless approved otherwise by the ENGINEER.
I. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.
J. Design and construct attachments and supports transferring seismic and non-seismic loads to the structure of materials and products suitable for application and in accordance with design criteria shown on the Drawings and nationally recognized standards.
K. Provide cast-in-place anchor bolts for anchorage of equipment to concrete or masonry as specified in SECTION 05 50 00. Provide anchor bolts of the size, minimum embedment, material, and spacing designated in calculations submitted by the CONTRACTOR and accepted by the ENGINEER.
L. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry as specified in SECTION 03 15 05. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by the CONTRACTOR and accepted by the ENGINEER.
M. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for non-vibration isolated mechanical equipment rated over 10 hp.

3.2 INSTALLATION
A. Do not install components or their anchorages or restraints prior to review and acceptance by the ENGINEER and the AHJ.
B. Notify the ENGINEER upon completion of the installation of seismic restraints as specified in SECTION 01 40 00.

3.3 QUALITY CONTROL
A. As specified in SECTION 03 15 15 and SECTION 05 12 00.
B. OWNER-furnished quality assurance, in accordance with ICC IBC, Chapter 17 requirements, is provided in the Project's Statement of Special Inspections on the Drawings. The CONTRACTOR's responsibilities and related information shall be as specified in SECTION 01 40 00.
C. The CONTRACTOR and Supplier responsibilities to accommodate the OWNER-furnished shop fabrication related special inspections and testing are provided in the Project's Statement of Special Inspections on the Drawings and as specified in SECTION 01 40 00.
D. Provide source quality control for welding and hot-dip galvanizing of anchors as specified in SECTION 05 12 00.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 15 05
ANCHORING TO CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for anchoring to concrete.

B. Related Sections:

1. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
2. SECTION 03 21 00 – REINFORCING STEEL
3. SECTION 03 62 00 – NON-SHRINK GROUTING

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 318 – Building Code Requirements for Structural Concrete
2. 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete

B. American National Standards Institute (ANSI):

1. B212.15 – Cutting Tools – Carbide-Tipped Masonry Drills and Blanks for Carbide-Tipped Masonry Drills

C. ASTM International (ASTM):

1. A 193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
2. A 240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
3. B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
4. C 882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
5. D 695 – Standard Test Method for Compressive Properties of Rigid Plastics
6. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
7. F 1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

D. International Association of Plumbing and Mechanical Officials – Uniform Evaluation Service (IAPMO-UES):

1. ER – Evaluation Report

E. International Code Council (ICC):

1. International Building Code (IBC), Section 1704 – Special Inspections, Contractor Responsibility and Structural Observations

F. International Code Council Evaluation Service, Inc. (ICC-ES):

1. AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements
2. AC58 – Acceptance Criteria for Adhesive Anchors in Cracked and Uncracked Masonry Elements
3. AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
4. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
5. ESR – Evaluation Services Report

G. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

1.3 DEFINITIONS

A. AAI: ACI/CRSI Adhesive Anchor Installation Certification Program.

B. IAPMO-UES: Reports published by IAPMO-UES in accordance with the ICC-ES Acceptance Criteria for the specific type of anchor installed into a specific material.

C. ICC-ES Reports: Reports published by ICC-ES in accordance with the ICC-ES Acceptance Criteria for the specific type of anchor installed into a specific material.

D. Special Inspection: In accordance with ICC IBC Section 1704.

1.4 SUBMITTALS

A. Product Data:

1. Current ICC-ES or IAPMO-UES ER for each anchor to be used with cracked and uncracked approvals under the governing ICC IBC code.
2. Product and technical data for adhesives, grouts, and bonding agents.
3. Current test data indicating the cured adhesive meets or exceeds the design loads required.
4. Mill certification reports for all-thread anchors and reinforcing steel bars.
5. SDS.

B. Shop Drawings: Reinforcing steel dimensions and mechanical properties including splice lengths.

C. Quality Control Submittals:

1. The Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors, or adhesive, and handling of cartridges, nozzles, and equipment.
2. The Adhesive Doweling System Manufacturer's current ICC-ES ESR or IAPMO-UES ER.
3. Detailed step-by-step instructions for special inspection procedure in accordance with ICC-ES ESR or IAPMO-UES ER and ICC IBC, Section 1704.
4. A copy of the Manufacturer's operation and repair manuals for each type of equipment used in the Work.
5. A copy of the attached AAI certification record submittal sheet filled out for each proposed installer of adhesive anchors horizontally or upwardly inclined to support sustained tension loads in accordance with ACI 318. Also provide a copy of the AAI certificate for each installer.
6. Supplements listed in this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
   1. Deliver products to the Work site in the Manufacturer's undamaged packaging complete with installation instructions.
   2. Protect, store, and handle materials in accordance with the Manufacturer's instructions.
   3. Dispose of any product not stored in accordance with the Manufacturer's recommended conditions.
   4. Container markings: Include the Manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, appropriate ANSI handling precautions, and SDS.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Expansion Anchors for Attachment to Concrete:
   1. Hilti, Inc., Hilti Kwik Bolt TZ
   2. Powers Fasteners, Inc., Power-Stud+ SD1 or Power-Stud+ SD2
   3. Simpson Strong-Tie, Strong-Bolt 2

B. Expansion Anchors for Attachment to Grout-Filled Masonry:
   1. Hilti, Inc., Hilti Kwik Bolt 3
   2. Powers Fasteners, Inc., Power-Stud+ SD1
   3. Simpson Strong-Tie, Strong-Bolt 2 or Wedge-All

C. Screw Anchors for Attachment to Concrete:
   1. Hilti, Inc.: Hilti Kwik-Hus EZ
   2. Powers Fasteners, Inc., Screw-Bolt+
   3. Simpson Strong-Tie, Titen HD

D. Adhesive Anchor Systems for Attachment to Concrete:
   1. Hilti, Inc., RE 500 V3 Adhesive or HIT-HY 200
   2. Powers Fasteners, Inc., PE1000+ Epoxy System or AC100+ Gold Adhesive
   3. Simpson Strong-Tie, SET-3G Epoxy or AT-XP Adhesive

E. Adhesive Anchor Systems for Attachment to Grout-Filled Masonry:
   1. Hilti, Inc., HIT-HY 200
   2. Simpson Strong-Tie, SET-3G or AT-XP Adhesive
   3. Powers Fasteners, Inc., PE1000+ Epoxy System or AC100+ Gold Adhesive

2.2 MATERIALS

A. Expansion Anchors for Attachment to Concrete:
   1. Tested and approved for cracked and uncracked concrete in accordance with ICC-ES AC193 requirements including wind and seismic loading.
   2. Stud shall be manufactured from carbon steel or SST as shown on the Drawings with an integral cone expander. The multi-segment expansion clip shall be manufactured from carbon steel or ASTM A 240 Type 316 SST. The carbon steel stud shall have, at a minimum, an electroplated zinc finish in accordance with ASTM B 633, Class SC1.

B. Expansion Anchors for Attachment to Grout-Filled Masonry:
   1. Tested and approved in accordance with ICC-ES AC01.
   2. Stud shall be manufactured from carbon steel or ASTM A 240 Type 316 SST as shown on the Drawings with an integral cone expander. The expansion clip shall allow 360-degree contact with the base material. The carbon steel stud shall have, as a minimum, an electroplated zinc finish in accordance with ASTM B 633, Class SC1.

C. Screw Anchors for Attachment to Concrete:
   1. Tested and approved for cracked and uncracked concrete in accordance with ICC-ES AC193 requirements including wind and seismic loading.
   2. Anchor shall be manufactured from carbon steel or ASTM A 240 Type 316 SST as shown on the Drawings.

D. Adhesive Anchor Systems for Attachment to Concrete:
   1. Tested and approved for cracked and uncracked concrete in accordance with ICC-ES AC308 or ACI 355.4.
   2. Two-component, high-solids, non-sag adhesive, approved for damp-hole installations, designed to be used in adverse freeze/thaw environments, adequate for horizontal and vertical applications.
   3. Cure temperature, pot life, and workability: Compatible for intended use and environmental conditions.
   4. Adhesives in contact with potable water shall have NSF/ANSI 61 compliance.
   5. For overhead and horizontal adhesive installations, follow the Manufacturer's instructions including using additional retaining caps or piston plugs as required.
   6. For mixing, follow the Manufacturer's instructions using the required nozzle.
   7. Mixed epoxy adhesive:
      a. Non-sag light paste consistency containing the following properties:
         1) Bond strength, in accordance with ASTM C 882: 3,500 psi minimum at 2 days.
         2) Compressive yield strength, in accordance with ASTM D 695: 10,000 psi, minimum.
         3) Characteristic bond strength in accordance with ICC-ES AC308 for 1/2 inch diameter rod of 1,450 psi minimum in uncracked concrete, temperature range 1/A.
         4) Passes ICC-ES AC308 cracked concrete tests for long-term creep at elevated temperatures and is approved under ICC-ES AC308 for horizontal and overhead applications.

E. Adhesive Anchor Systems for Attachment to Grout-Filled Masonry:
   1. Two-component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.
   2. Cure temperature, pot life, and workability: Compatible for intended use and environmental conditions.
   3. Requirements for masonry embedment: Tested and approved in accordance with ICC-ES AC58.

F. Anchor Rods:
1. Threaded steel rods:
a. Carbon steel rods shall be in accordance with ASTM F 1554 Grade 36 or ASTM A 193 Grade B7 as shown on the Drawings.
b. SST rods shall be in accordance with ASTM F 593 or ASTM A 193 Grade B or B8M.
c. Nuts and washers shall be furnished to meet the material requirements of the anchor rod specifications.
2. Internally threaded inserts: Provide SST or carbon steel material compatible with the requirements of the anchor rod specifications.
3. Reinforcing bars: As specified in SECTION 03 21 00.

PART 3 EXECUTION

3.1 GENERAL

A. Expansion and Screw Anchor Requirements:
1. Use Manufacturer recommended special tools for the installation of anchors.
2. Holes drilled in concrete and masonry shall be drilled accurately and squarely and shall be sized and cleaned in accordance with the Manufacturer's instructions.

B. Adhesive Anchor Requirements:
1. Use Manufacturer recommended special tools for the installation of anchors.
2. Holes drilled in concrete and masonry shall be drilled accurately and squarely and shall be sized and thoroughly cleaned in accordance with the Manufacturer's instructions.
3. Dispense epoxy adhesive components through the Manufacturer's specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at the base of the predrilled hole.
4. Do not use epoxy where fire or temperatures above 100°F can occur.
5. Minimum base material temperature shall be verified as required by the Manufacturer. The temperature of base material shall be verified before adhesive installation begins. Base material temperature shall be kept above the Manufacturer's minimum specified cure temperature for the entire cure time.
6. Install in accordance with the Manufacturer's instructions starting adhesive dispensing at the bottom of the cleaned hole.
7. Mixing nozzles:
a. Install using the Manufacturer's specially designed static mixing nozzle that thoroughly mixes adhesive in accordance with the Manufacturer instructions.
b. A non-removable internal static mixer is required to ensure proper blending of components.
8. Adhesive cartridge system:
a. A disposable, two-component, self-contained cartridge system capable of dispensing both components in the proper mixing ratio, that fits into a manually or pneumatically operated dispensing gun.
b. Dispense components through a specially designed static mixing nozzle that thoroughly mixes components and dispenses adhesive at the base of the predrilled hole.

3.2 INSTALLATION

A. Install anchors in accordance with instructions in the approved ICC-ES or IAPMO-UES ER. Where conflicts exist between the approved ICC-ES report or IAPMO-UES ER and the requirements in this Section, the requirements of the ICC-ES ESR or ER shall control.
B. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by installers with the AAI certification.
C. Do not install anchors in concrete less than 7 days after placement.
D. Do not install anchors in concrete less than 28 days after placement unless field cylinders have attained 100% of the specified minimum 28-day compressive strength.
E. Notify the ENGINEER in writing when field cylinders are needed to determine in-place concrete strength for installation of anchors prior to 28 days.
F. Clean each hole prior to adhesive installation as recommended by the Manufacturer. At a minimum, clean in accordance with the following procedure:
1. Insert an air nozzle that reaches the bottom of the hole and blow out loose dust. Use air that is free of oil, water, or other contaminants that will reduce bond.
2. Use a stiff bristle nylon or wire brush, as required by the Manufacturer, to vigorously brush the hole to dislodge compacted drilling dust.
3. Repeat step 1.
4. Repeat the steps as required to remove drilling dust or other material that will reduce bond.
G. Drilling Equipment:
1. Hole drilling equipment: Electric or pneumatic rotary type drills with medium or light impact settings.
2. Drill bits: Carbide-tipped in accordance with ANSI B212.15.
3. Hollow drills with flushing air systems are preferred. Air shall be free of oil, water, or other contaminants that will reduce bond.
4. Where edge distances are less than 2 inches or thickness is less than 6 inches, use lighter impact equipment to prevent microcracking and concrete spalling during the drilling process.
5. Core drilling holes is not permitted unless specifically detailed in the Drawings or approved in writing by the ENGINEER.
H. Hole Diameter: As recommended by the Manufacturer; use a drill bit diameter meeting ICC-ES ESR or IAPMO-UES ER requirements and as recommended by the Manufacturer.

I. Install anchor, rebar, internally threaded insert, or all-thread rods to the depth, spacings, and locations as shown on the Drawings.

J. Obstructions in Drill Path:

1. When existing reinforcing steel is encountered during drilling:
   a. If relocation of the anchor or reinforcing bar is possible, re-drill the hole 1 inch from its original location, redirecting the drill to miss the reinforcing steel.
   b. If the anchor cannot be relocated due to the bolt location in a fabricated item, consult the ENGINEER about core drilling holes or modifying the fabricated item.
   c. If core drilling is permitted by the ENGINEER, roughen it with a TE-YRT Hilti roughening tool in accordance with the Roughening Tool Manufacturer's and the Anchor/Anchor Adhesive Manufacturer's requirements.
2. Fill the mis-drilled hole completely with a category I or II non-shrink grout as specified in SECTION 03 62 00 prior to the installation of anchors.
3. When using adhesive anchors, dowels may be bent up to 15 degrees to align with other bars prior to installation. Do not heat dowels to bend.
4. If reinforcing bars have fused epoxy coating and the coating is damaged, recoat the damaged area with epoxy.
5. Bent bar dowels: Where edge distances are critical and encountering reinforcing steel is likely, drill a hole at a 10 degree angle or less and use pre-bent reinforcing bars.

3.3 QUALITY CONTROL

A. Operational Readiness Test Pre-Requisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting, or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER and ENGINEER, shall be paid by the CONTRACTOR.

1. Other tests:
   a. Special inspection shall be performed in accordance with the Manufacturer's submitted ICC-ES ESR or IAPMO-UES ER as required by the ENGINEER.
   b. Anchor proof-load testing: The ENGINEER may require torque tests or tension tests in addition to special inspection to determine the adequacy of anchors. The field-testing program will be established by the ENGINEER and performed in accordance with appropriate ASTM test standards by an independent testing agency. The percentage of each type and size of drilled-in anchor to be proof loaded by the independent testing agency will be determined by the ENGINEER.
      1) Field tests shall be non-destructive whenever possible.
      2) Adhesive anchors shall not be torque tested unless otherwise directed by the ENGINEER.
      3) If more than 10% of tested anchors fail to achieve the specified torque or proof load within limits defined on the Drawings, anchors of the same diameter and type as the failed anchors shall be tested at the CONTRACTOR's expense, unless otherwise instructed by the ENGINEER.
      4) Torque tests shall be applied with a calibrated torque wrench.
      5) Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive anchors at proof load shall not exceed the limits determined by the independent testing agency or the ENGINEER.
      6) Anchors determined to be improperly installed from these test results shall be removed and replaced at the CONTRACTOR's expense. Additionally, fill empty anchor holes and patch failed anchor locations with a category I or II non-shrink grout as specified in SECTION 03 62 00.

3.4 SUPPLEMENTS

A. Supplement A – ACI – CRSI Adhesive Anchor Installer (AAI) Certification

END OF SECTION

ACI – CRSI Adhesive Anchor Installer (AAI) Certification Program

AAI Certification Record and Project Submittal Sheet

(Please print or type in black or blue ink)

Part 1 - Installer Information

Last Name	First Name	Middle Initial	Home Telephone

Mailing Street Address	Cellular Telephone

City	State	Zip Code

Current Employer	Office Address

City	State	Zip Code

Part 2 - Certification Record

(attach copy of official ACI card)

Certification Number	Full Name (as it appears on your card)	Expiration Date

Test Date	Test Location	Sponsoring Group

Part 3 - Record of Additional AAI Training

(self reporting)

Training Date	Manufacturer	Adhesive System	Training Location	Instructor(s)	Training Length (hrs)

Notes:
(1) The contract documents may require verification of the additional training obtained for the adhesive anchor system listed on drawings or in the specifications used on a specific project. Please attach to this form any verification records of additional manufacturer training.
(2) For Part 3 of this form, attach additional sheets, as necessary, to document your further training by the manufacturer(s).

09-2011 Page 1 of 2 Form: ACI-CRSI AAI Record

Part 4 – Submittal Review Section	*(to be completed by the design professional)*
Specification Section: _____	Date Submitted: _____
Affix submittal and review stamps in this area.	Reviewed by:
Review comments / notes:	

SECTION 03 15 13
POLYVINYL CHLORIDE WATERSTOP

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for polyvinyl chloride waterstop.

1.2 REFERENCES
- A. Corps of Engineers (COE):
  1. CRD-C 572 – Specifications for Polyvinylchloride Waterstops
- B. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. Quantity and types of pre-manufactured joints/intersections.
  2. Waterstop profiles to be used.
  3. Splicing information, including Manufacturer's report of test results for a field butt splice by the CONTRACTOR.
  4. Data sheets for waterstop accessories, including hog rings.

1.4 QUALITY ASSURANCE
- A. The components and installation procedures shall be in accordance with the Manufacturer's instructions.
- B. Installation shall be performed by skilled workers trained in the procedures and methods required for the proper installation and performance of the waterstop.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver the waterstop materials to the Work site in the Manufacturer's unpacked containers with labels intact and legible at the time of use.
- B. Materials shall be stored in a secure, indoor, dry area. Maintain waterstops in a dry condition during delivery, storage, handling, installation, and concealment.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. PVC Waterstops, 6 Inch:
  1. Greenstreak Group, Inc.

2.2 MATERIALS
- A. General: Materials shall be in accordance with NSF/ANSI 61.
- B. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin PVC. Compound shall not contain scrapped material, reclaimed material, or pigment.
- C. Specific Gravity: Approximately 1.37.
- D. Shore Durometer Type A Hardness: Approximately 80.
- E. Performance Requirements: In accordance with COE CRD-C 572.
- F. Type Required in All Expansion, Contraction, and Control Joints: 6 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as shown on the Drawings.
- G. Type Required in Construction Joints: Flat ribbed, 6 inches wide with parallel longitudinal ribs or protrusions on each side of strip center.
- H. Corrugated or tapered type waterstops are not acceptable.
- I. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.
- J. Minimum Weight per Foot of Waterstop:
  1. 1.60 lbs for 3/8 inch by 6 inches.
- K. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.
- L. Fittings:
  1. Meet the physical properties described herein.
  2. Factory fabricate fittings such as tees, ells, and crosses.

PART 3 EXECUTION

3.1 GENERAL
- A. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
- B. Join waterstop at intersections to provide continuous seal.
- C. Center waterstop bulb on joint.
- D. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets, hog rings, or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
- E. Repair or replace damaged waterstop.
- F. Place concrete and vibrate to obtain impervious concrete in vicinity of waterstop.
- G. Joints in Footings and Slabs:
  1. Ensure that space beneath horizontal waterstop is completely filled with concrete.
  2. During concrete placement, make visual inspection of waterstop area.
  3. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

3.2 PREPARATION
- A. Store waterstops under protective tarps to keep free of oil, dirt, and UV degradation; unprotected waterstops will be rejected.
- B. Uncoil and lay waterstops flat a minimum of 2 days prior to installation.

C. Do not lay waterstops in mud or debris.
D. Protect waterstops from punctures.
E. Repair Waterstops After Shipping:
   1. Heat the waterstop to the range of 125°F to 150°F in accordance with the Manufacturer's instructions to re-establish proper waterstop configuration which may have been altered due to shipping in rolls; e.g., tear web or large bulb becoming flattened against waterstop legs.
   2. Tear web bulbs shall be perpendicular to embed the legs of the waterstop and have proper shape.
   3. Circular bulbs shall be round and in proper alignment to embed legs.
F. Coordinate reinforcement placement and positioning for proper installation of the waterstop.
G. Pre-fabricate waterstops for use in pipe slab penetrations to achieve proper shape and waterstop geometry including proper bulb configuration and alignment.

3.3 INSTALLATION

A. Placement:
   1. When installed in expansion joints, place centerbulb or tear web bulb, depending on the type of waterstop, un-embedded and centered in joint.
   2. Waterstop shape:
      a. Bulbs shall conform to proper geometry, shape, and orientation.
      b. A tear web bulb or bulb type waterstop that is not in conformance with proper geometry, shape, and orientation, as detailed and illustrated by the Manufacturer and the Drawings, shall be removed and replaced.
   3. Secure waterstop:
      a. Securely tie the waterstop to reinforcing steel using hog rings crimped between the last two ribs or into the end bulb at 12 inch maximum centers.
      b. Tie both portions of the waterstop that will be encased in concrete and portions initially not encased to support at 12 inch centers to assist in maintaining the waterstop alignment during concrete placement.
B. Field Splices:
   1. Only butt splices are permitted to be spliced in the field. Butt splices shall be made by the method of continuous heat welding using a Manufacturer-approved waterstop welding iron.
   2. Splice PVC waterstops neatly and in accordance with the Manufacturer's instructions.
   3. Excessive PVC weld spatter is not acceptable.
   4. A maximum of one splice is permitted in 50 lf of waterstop.
C. Concrete Placement:
   1. Thoroughly and systematically vibrate concrete around the waterstop for positive contact between the waterstop and concrete.
   2. Clean horizontal joints so that dirt and construction debris do not interfere with the direct contact of concrete with the waterstop.
   3. When placing concrete, avoid deflecting the waterstop out of its proper position.
   4. Bring concrete up in uniform lifts on both sides of the waterstop to promote proper waterstop alignment.
D. Placement Tolerance: The waterstop shall be no more than 1/2 inch from the designed horizontal alignment and within 1/4 inch of vertical alignment.
E. Splice Joint Identification: After concrete has hardened, mark the location of splices on the top surface of the concrete for future reference in the event of water seepage through a joint in the waterstop.

END OF SECTION

SECTION 03 15 14
THERMOPLASTIC ELASTOMERIC RUBBER WATERSTOP

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for thermoplastic elastomeric rubber waterstop.

B. Related Sections:

1. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
2. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES

A. ASTM International (ASTM):

1. D 471 – Standard Test Method for Rubber Property – Effect of Liquids
2. D 638 – Standard Test Method for Tensile Properties of Plastics
3. D 2240 – Standard Test Method for Rubber Property – Durometer Hardness

B. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer’s data sheets.
2. Installation instructions.
3. TPE-R Waterstop Manufacturer’s test data for chemical resistance.
4. The Waterstop Manufacturer's instructions for product shipment, storage, handling, installation, field splices, and repair.
5. Epoxy and SST anchors for retrofit applications.
6. Manufacturer’s provided epoxy and SST anchors for retrofit applications.

B. Shop Drawings:

1. Details of the splices to be used on the waterstop, the method of securing the waterstop in forms, and the waterstop support to maintain proper orientation and location during concrete placement.
2. The layout and location of construction joints indicating the type to be used.
3. Joint fillers for sloped and horizontal joints.

C. Samples:

1. Splice, joint, and fabricated cross of each size, shape, and fitting of the waterstops proposed for use.
2. Tape for closed-cell foam joint filler.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.

B. Components and installation procedures shall be in accordance with the Manufacturer's instructions.

C. Waterstop splicing defects that are not acceptable include, but shall not be limited to:

1. Use of adhesives, solvents, and free lap joints.
2. Misalignment that reduces waterstop cross-section area more than 15%.
3. Visible porosity in the welded joint, including pinholes, charred, or burnt material.
4. Visible signs of splice separation when cooled splices are bent by hand at a sharp angle.
5. Edge welding.

1.5 DELIVERY, STORAGE, AND HANDLING

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:

1. Deliver materials to the Work site in the Manufacturer's unpacked containers with labels intact and legible at the time of use.
2. Prior to unloading and storing on-site, verify that waterstops are in accordance with the cross-section dimensions shown on the Drawings and the Manufacturer's product data.
3. Store materials in a secure, indoor, dry area.
4. Store waterstops under tarps; protect from oil, dirt, and UV degradation.
5. Maintain materials in a dry condition during delivery, storage, handling, installation, and concealment.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. JP Specialties, Earth Shield

B. Sika Corporation, Westec Envirostop TPER Waterstops

2.2 MATERIALS

A. General: Materials shall be in accordance with NSF/ANSI 61.

B. Extruded from TPE-R compound. Compound shall not contain scrapped material, reclaimed material, or pigment.

C. Synthetic rubber waterstop with high resistance to a wide range of oils, solvents, and chemicals.

D. Type: Center bulb with a number of parallel ribs or protrusions on each side of the strip center.

E. Minimum Tensile Strength: 2,000 psi in accordance with ASTM D 638.

F. Ultimate Elongation: 450% in accordance with ASTM D 638.

G. 100% Modulus: 1,000 psi in accordance with ASTM D 638.

H. Shore Durometer Type A Hardness: 85 in accordance with ASTM D 2240.

I. Chemical resistance testing shall be performed by an independent ASTM certified laboratory. The waterstop shall not have more than 30% change in material properties including weight gain after 7-day exposure to fluids contacted in accordance with ASTM D 471 testing.
J. Minimum Weight Per Foot of Waterstop: 3/8 inch by 6 inch, 0.55 lb.
K. Nonmetallic Waterstop Shop Splice Fabrications: Provide factory-fabricated waterstop intersections leaving only straight butt joint splices for the field.

PART 3 EXECUTION

3.1 GENERAL

A. Use TPE-R waterstops at containment slabs, curbs, and walls where oils will be contained, such as a transformer containment slab area.
B. Construct straight vertical or horizontal joints, except where walls intersect sloping floors.
C. Begin concrete placement after joint preparation is complete.
D. The time between concrete placements shall be as specified in SECTION 03 30 00.
E. Construction joints not shown on the Drawings shall be approved by the ENGINEER and be installed as specified in SECTION 03 30 00.
F. Install continuous waterstop in construction joints, unless otherwise shown on the Drawings.

3.2 INSTALLATION

A. General:
   1. Join waterstop at intersections using pre-manufactured joints to provide a continuous seal.
   2. Center waterstop on the joint.
   3. Secure waterstop in the correct position to avoid displacement during concrete placement.
   4. Repair or replace damaged waterstop.
   5. Place concrete and vibrate to obtain impervious concrete near joints.
   6. Joints in footings and slabs:
      a. Ensure the space beneath the waterstop is completely filled with concrete.
      b. During concrete placement, make a visual inspection of the waterstop area.
      c. Limit concrete placement to the elevation of the waterstop in the first pass. Vibrate concrete under the waterstop, lift the waterstop to confirm full consolidation without voids, and place remaining concrete to the full height of the slab.
      d. Apply procedure to the full length of the waterstop.

B. TPE-R Waterstop:
   1. Install in accordance with the Manufacturer's instructions.
   2. Splice in accordance with the Manufacturer's instructions using a thermostatically controlled heating iron.
      a. Provide factory-fabricated waterstop intersections.
      b. Field-splices shall be permitted only for straight butt welds.
      c. Waterstop intersections and directional changes shall be miter cut and heat welded with the center bulb and ribs aligned to maintain continuity.
      d. Splices shall be free from defects as specified in this Section.

END OF SECTION

SECTION 03 15 15
HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for hydrophilic rubber waterstop.
- B. Related Sections:
  1. SECTION 01 40 00 – QUALITY REQUIREMENTS
  2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
  3. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
  2. D 2240 – Standard Test Method for Rubber Property – Durometer Hardness
- B. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. Adhesives.
  2. Waterstops.

1.4 QUALITY ASSURANCE
- A. The components and installation procedures shall be in accordance with the Manufacturer's instructions.
- B. Installation shall be performed by skilled workers trained in the procedures and methods required for the proper installation and performance of the HR waterstop.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
  1. Deliver the HR waterstop materials to the Work site in the Manufacturer's unopened containers with labels intact and legible at the time of use.
  2. Materials shall be stored in a secure, indoor, dry area.
  3. Maintain the HR waterstops in a dry condition during delivery, storage, handling, installation, and concealment.

1.6 WARRANTY
- A. As specified in SECTION 01 60 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. HR Waterstop:
  1. Adeka Corporation:
     a. KBA-1510FP
     b. MC-2005T
     c. MC-2010MN
     d. KM-3030M
  2. Greenstreak Group, Hydrotite
- B. Adhesive:
  1. 3M, Neoprene High Performance Rubber and Gasket Adhesive 2141
  2. Bostik, 1142M
- C. Spray Adhesive:
  1. 3M, Adhesive Spray 77
- D. Sealant:
  1. Adeka Corporation, P-201
  2. Greenstreak Group, Leakmaster LV-1
- E. Solvent:
  1. 3M, Solvent No. 2

2.2 MATERIALS
- A. General: Materials in contact with potable water shall be certified in accordance with NSF/ANSI 61.
- B. Material shall be a non-bentonite HR compound.
- C. The waterstop shall have the following minimum properties:
  1. Tensile strength 130 psi in accordance with ASTM D 412.
  2. Elongation 550% in accordance with ASTM D 412.
  3. Hardness 30 Shore A Durometer in accordance with ASTM D 2240.
- D. Performance: Time period to maximum volume expansion: 35 days.

PART 3 EXECUTION

3.1 GENERAL
- A. Coordinate with other trades and SECTION 03 30 00 to ensure the proper execution of the HR waterstop installation.
- B. Examine the concrete surface and correct any surface imperfections that will prevent the proper installation and performance of the HR waterstop.
- C. Finish the concrete surface with a steel trowel finish prior to surface preparation.

3.2 PREPARATION

A. Clean concrete surfaces of dirt, saw dust, laitance, grease, form oils, form release agent, or other contamination.
B. Prior to adhering the HR waterstop to the concrete, blast the concrete with a light sand blast, wash with a wet broom, and dry. If approved, brush with a wire brush in lieu of a light sand blast.
C. After cleaning, the concrete shall be completely clear of construction debris and free of curing compound, oil, grease, concrete dust, and other materials that will prevent the complete bonding of the HR waterstop to the concrete.
D. Grind smooth any surface deformations in the concrete that will prevent adhesion of the HR waterstop to the concrete or level with repair grout or elastic sealant to the satisfaction of the ENGINEER.

3.3 INSTALLATION

A. Place concrete within 12 hours of the HR waterstop installation.
B. Prior to removing the forms, ensure adequate concrete strength has been developed and there is proper cover to the free edge in accordance with the Manufacturer's instructions to avoid spalling.
C. Waterstop Placement:
    1. Measure and cut the exact length of the HR waterstop.
    2. Splices are not permitted in the HR waterstop in vertical wall joints of structures.
    3. Splices in horizontal joints are acceptable.
    4. Only one splice is permitted in 25 feet or in changes in alignment.
    5. Splice HR waterstops in horizontal joints by butting and gluing the ends of the HR waterstop with approved adhesive.
    6. Clearances:
        a. In accordance with the Manufacturer's instructions for the minimum clearance to concrete face.
        b. Unless greater clearance is recommended by the Manufacturer, the minimum clearance shall be 4 inches for concrete compressive strength of 3,000 psi and greater.
        c. Use greater clearance if the recommended clearance is more than 4 inches or concrete strength is less than 3,000 psi, especially when forms are stripped.
    7. Placement of the HR waterstop shall be in accordance with the Contract Documents.
    8. The HR waterstop shall be clean and free of foreign substances. HR waterstops that are not clean and free of foreign substances shall not be used.
    9. The ENGINEER will review the length of the HR waterstop to be adhered to concrete prior to placement.
    10. Adhesive application:
        a. Apply a uniform brush coat of adhesive to both surfaces using a thin brush.
        b. Install waterstop on the concrete while the adhesive on both the rubber and the concrete surfaces are tacky.
        c. Do not apply a bead of adhesive to the concrete in excess of the Manufacturer's recommendations.
        d. Excess adhesive on the concrete is not acceptable and shall be removed.
        e. Gaps in adhesive application are not permitted.
        f. After the adhesive has dried to a tacky condition.
        g. When installing the HR waterstop on curved surfaces such as pipes, use temporary bands (e.g., wire or rope) to assist in securing the HR waterstop to the surface.
        h. Remove any temporary means of securing the HR waterstop prior to placing concrete or grout.
        i. After the adhesive has cured, check HR waterstop adhesion. If it can be pulled from the concrete, reapply adhesive to the HR waterstop, and repeat the preceding steps to secure the HR waterstop to the concrete.
    11. Cleanup:
        a. Remove excess adhesive from concrete using an approved solvent.
        b. When using solvent, follow the Manufacturer's instructions carefully including extinguishing sources of ignition from the area.
    12. When the HR waterstop contains SST screen, orient the HR waterstop with the screen parallel to the construction joint.
    13. After attaching the HR waterstop to the concrete joint in dry conditions, spray a coat of the approved spray adhesive to completely cover the waterstop. HR waterstop protected in this manner is protected from water, and is not subject to the specified 48-hour requirement for concrete placement, so long as the spray adhesive coating is intact.
D. Sealant Curing:
    1. Sealant shall be placed in all concrete construction joints prior to concrete placement.
    2. Curing times and bead sizes shall be in accordance with the sealant Manufacturer's recommendations.
E. Concrete Placement:
    1. Place concrete within 48 hours of the HR waterstop installation.
    2. Protect the HR waterstop from water and displacement prior to concrete placement.
    3. During concrete placement, visually observe the HR waterstop to ensure specified placement and alignment.
F. Placement Dimension:
    1. To the free edge of concrete: 4 inches, with a tolerance of 0 inches to +1/2 inches.
    2. Proper HR waterstop orientation:
        a. Place the long dimension of unreinforced HR waterstops parallel to the construction joint.
        b. Place reinforced HR watertops with reinforcement parallel to the construction joint.
G. Concrete Strength Prior to Form Removal:
    1. Obtain current data from the Manufacturer regarding required concrete strength and cover to the free edge prior to removing forms at the construction joint.
    2. If concrete spalls at the joint, submit the means and methods of repairing the joint prior to perform the repair.

3.4 QUALITY CONTROL

A. Quality Control in accordance with IBC Chapter 17 requirements in the Statement of Special Inspections Plan on the Drawings. The CONTRACTOR responsibilities and related information shall be as specified in SECTION 01 40 00.

B. The ENGINEER or their designated representative shall inspect 100% of the installation of HR waterstop. The CONTRACTOR shall coordinate installation and inspection with the ENGINEER prior to placing concrete.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 15 16
CHEMICAL GROUT WATERSTOP

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for chemical grout waterstop.
- B. Related Sections:
  1. SECTION 01 40 00 – QUALITY REQUIREMENTS
  2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
  2. D 3574 – Standard Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams
- B. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. Chemical grout waterstop.
  2. Grout pump.
  3. Safety data sheets.
  4. Clip fasteners.

1.4 QUALITY ASSURANCE
- A. Components and Installation Procedures: In accordance with the Manufacturer's instructions.
- B. Installation Requirements:
  1. Under direct supervision of a Manufacturer's Representative.
  2. By the Manufacturer's licensed applicator.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
  1. Deliver the chemical grout waterstop materials to the Work site in the Manufacturer's unopened containers with labels intact and legible at the time of use.
  2. Materials shall be stored in a secure, indoor, dry area.
  3. Store grout tubes and chemical grout on-site and readily available prior to starting Work.

1.6 WARRANTY
- A. As specified in SECTION 01 60 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Permeable Grout Tubes:
  1. De Neef, Inc.
- B. Chemical Grout:
  1. De Neef, Inc., Flex LV PURe Chemical Grout
- C. Electric Grout Pumps:
  1. Graco, 395 or 495

2.2 MATERIALS
- A. Permeable Grout Tubes:
  1. Constructed to resist the pressures of freshly placed concrete.
  2. A filter layer to prevent the entry of cement particles into the tube yet allows for easy passage of chemical grout during injection over the length of the tube.
  3. Protection for the filter layer to resist the abrasive effects of concrete and aggregates.
- B. Chemical Grout:
  1. Hydrophobic polymer of isocyanate type.
  2. Installed by injection.
  3. Uncured polyurethane grout viscosity: 550 cps (at 77°F) and 100% solids.
  4. Sealing material:
     a. When the chemical grout is mixed with approximately 10% water, the sealing material shall expand and cure to closed-cell foam with tensile strength of 150 psi tested in accordance with ASTM D 412 and 250% elongation tested in accordance with ASTM D 3574.
     b. Ability to react in moving water.
     c. Viscosity to remain the same until gelation occurs.
  5. Capability to expand up to 300% in volume.
  6. NSF/ANSI 61 certified.
  7. Shrinkage: Less than 4% in accordance with ASTM D 3574.

2.3 ACCESSORIES
- A. Accelerator:
  1. Control reaction time from 1 minute to 1 hour.
  2. Viscosity: 5 cps at 68°F.
- B. Water: Potable water to flush grout tubes.
- C. Mixing Tanks: Plastic or metal.

PART 3 EXECUTION

3.1 GENERAL

A. Install permeable grout tubes at the locations shown on the Drawings.
B. Place tubes to avoid potential pinching by reinforcing steel and form ties with a minimum clearance of 1 1/2 inches.
C. Work shall be continuous from start to completion.

3.2 PREPARATION

A. Clean surfaces and ensure surfaces are free of dirt, saw dust, laitance, grease, form oils, or other contamination prior to the installation of grout tubes.
B. Grout Injection:
   1. After the concrete has cured, expose and clean grout ports. If grouting is to be performed later in the Work, protect the port from damage and from the intrusion of foreign material and water.
   2. Schedule injection process as determined by the ENGINEER or as shown on the Drawings.
   3. Do not perform grouting during conditions where water in the tube may freeze, unless otherwise reviewed and accepted.
   4. Insert a hose barb and secure the barb to the tube.
   5. Testing:
      a. Test each section of tube with water to a minimum pressure of 100 psi to ensure it is clear.
      b. When testing the grout tube, avoid the displacement of bearing pads used to support the wall.
      c. In locations where excessive water leakage can occur due to poorly consolidated and vibrated concrete, the grout tube may require additional accelerator to speed the grout set time and prevent excessive grout loss.
      d. Flush water through the tubes and pressurize.
   6. Blockage:
      a. If a blockage is encountered, promptly inform the ENGINEER and determine the means and methods necessary to clear it.
      b. If flushing does not eliminate the blockage and leaks present, the ENGINEER will require the installation of drilled holes for the mechanical injection of chemical grout.
   7. Do not commence grouting until all sections of the tube have been pressure tested.
C. Grout Mixing and Handling:
   1. Mix and handle grout in accordance with the Manufacturer's instructions.
   2. Perform mixing and handling in a manner as to prevent the contamination of the grout with materials, such as dirt or debris, which could prevent proper installation and curing.

3.3 INSTALLATION

A. Securely fasten grout tubes to concrete surfaces, or PVC waterstops, if shown on the Drawings, using clip fasteners every 12 inches.
B. Cut tubes using a wire cutter.
C. Do not install a grout tube that is frayed or cut. Remove or replace a grout tube that is frayed or cut or that will permit intrusion of cement paste.
D. Ensure the direct contact of grout tubes with the surface of the waterstop it is to be attached to. Adjust grout tubing to provide for 100% contact by stretching the tube and adjusting clip fasteners. Gaps between the tube and the surface are not acceptable.
E. Grout Tube Ports:
   1. Securely fasten tees for grout ports to the tube.
   2. If required, tape the port to the tube.
   3. Extend a minimum of 12 inches outside of the concrete form face and a minimum of 12 inches into the concrete.
   4. Place to avoid conflicts with bearing pads and other appurtenances.
   5. Unless otherwise shown on the Drawings or necessitated by construction, place tees and grout ports every 100 feet at a maximum.
F. Exercise caution to avoid crimping the tube against items that will prevent the flow of grout through the tube.
G. Overlap tubes by a minimum of 1 inch with tube trumpets fixed tightly together.
H. Extend the end of clear reinforced PVC tubing a minimum of 1 foot outside of the form or concrete. Cover the tube opening with tape to prevent debris from entering.
I. During the final review of the installation, use duct tape to cover any frayed or cut tube that will permit the intrusion of cement paste if it cannot practically be removed and replaced.
J. No more than 2% of the tube can be repaired with tape, as determined by length of repair versus total length between grout ports. If more than 2% is taped, remove and replace the tubing.
K. Prior to closing forms, review the tube to ensure the flow of grout from port to port.
L. Chemical Grout Injection:
   1. Process:
      a. After the completion of concrete Work, cleaning of the port, flushing and pressurizing of the tube, and after the post-tensioning of the structure; inject chemical grout through the grout ports.
      b. Provide enough pressure to ensure a thorough and proper injection.
      c. As soon as material appears at the other end of tube, close the effluent port and increase the pump pressure to force the injection of grout into small voids or cracks.
      d. Terminate the injection of chemical grout when the sealing material uniformly percolates out of the joint or a constant pressure is reached for a minimum of 3 minutes to a maximum of 5 minutes. Pressure may range from 5 psi to 1,000 psi depending on crack widths and void volumes.

2. Do not use accelerator unless faster set times are required due to grout loss through concrete voids and the use is approved by the ENGINEER.
3. For injection Work performed on a storage reservoir floor or wall joint with the wall supported by bearing pads:
    a. Continuously observe pads to confirm they are not being displaced by grout under pressure.
    b. Provide injection pressure to thoroughly inject the tube but low enough to avoid bearing pad displacement.

M. Do not remove ports until chemical grouting has been completed and approved.

3.4 REPAIRS

A. Trim back grout ports from the surface of the concrete to a depth of 1 inch and patch with materials as specified for form tie holes or tendon anchorage pockets.

3.5 QUALITY CONTROL

A. Quality Control in accordance with IBC Chapter 17 requirements in the Statement of Special Inspections Plan on the Drawings. The CONTRACTOR responsibilities and related information shall be as specified in SECTION 01 40 00.

B. The ENGINEER or their designated representative shall inspect 100% of the installation of chemical grout waterstop. The CONTRACTOR shall coordinate inspection of the installation with the ENGINEER.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 21 00
REINFORCING STEEL

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for reinforcing steel.
- B. Related Sections:
  1. SECTION 01 40 00 – QUALITY REQUIREMENTS

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 117 – Specification for Tolerances for Concrete Construction and Materials
  2. 301 – Specifications for Structural Concrete
  3. 315 – Guide to Presenting Reinforcing Steel Design Details
  4. 318 – Building Code Requirements for Structural Concrete
  5. SP-66 – Detailing Manual
- B. American Welding Society (AWS):
  1. D1.4 – Structural Welding Code – Steel Reinforcing Bars
- C. ASTM International (ASTM):
  1. A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  2. A 775 – Standard Specification for Epoxy-Coated Steel Reinforcing Bars
  3. A 1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- D. Concrete Reinforcing Steel Institute (CRSI):
  1. Manual of Standard Practice
  2. Recommended Practice for Placing Reinforcing Bars
- E. International Code Council Evaluation Services, Inc. (ICC-ES):
  1. AC 133 – Mechanical Splice Systems for Steel Reinforcing Bars
  2. ESR – Evaluation Services Report

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66.
  2. Detail plans, sections, reinforcing bar sizes, grades, placement, spacing, splice lengths, tail and hook configurations, chair and bolster heights, and development length where applicable.
  3. Mechanical threaded splice devices.
- B. Samples:
  1. Tie wire.
  2. Reinforcing bar support chairs and bolsters.
- C. Quality Control Submittals:
  1. Mill test reports.
  2. Epoxy coating certifications: Written certification from the Coating Manufacturer that samples representing each lot of coated steel reinforcing bars have been tested or inspected in accordance with ASTM A 775.
  3. Mechanical thread connections:
     a. Manufacturer's data sheets.
     b. Verification that device threads have been checked and meet the Manufacturer's requirements for thread quality.
     c. Certificate of compliance.
  4. Welder and welding qualifications.
  5. Test results for field welding.

1.4 QUALITY ASSURANCE
- A. Qualifications:
  1. Welding:
     a. Performed by welders and welding procedures certified in accordance with AWS D1.4.
     b. When welder or welding procedures certification tests are required, the testing shall be performed by an independent testing agency acceptable to the ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. In accordance with ACI 301 and CRSI Recommended Practice for Placing Reinforcing Bars.
- B. Reinforcing Steel:
  1. Stored on supports which prevent the steel from touching the ground.
  2. Protect from oil or other materials that are detrimental to steel or the bonding capability of the reinforcing bar.
  3. Protect from mechanical injury.
  4. Rust, seams, surface irregularities, or mill scale will not be cause for rejection provided the weight and height of deformations of the hand-wire-brushed test specimen are not less than the applicable ASTM specification.
- C. Do not drop or drag bars.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Tie Wire:
  1. American Wire Tie, Inc.
  2. Mar-Mac Wire Inc.

B. Mechanical Bar Splices:
   1. Barsplice Products
   2. Dayton Superior
   3. Erico Products, Inc.
   4. Richmond Screw Anchor Co., Inc.

2.2 MATERIALS

A. Reinforcing Steel:
   1. Bar steel reinforcement: Deformed type, ASTM A 615 Grade 60.
   2. Spirals:
      a. Hot-rolled plain or deformed bars in accordance with ASTM A 615.
      b. Spirals for columns: Provide spacers in accordance with ACI SP-66 in accordance with the suggested guidelines for spiral spacers to maintain proper pitch and spacing.

B. Welded Wire Fabric:
   1. Plain welded wire fabric in accordance with ASTM A 1064, Grade 70 or deformed welded wire fabric in accordance with ASTM A 1064 with wire size and spacing as shown on the Drawings.
   2. Furnish in sheet stock; roll stock is not acceptable.
   3. Horizontal masonry joint reinforcement: In accordance with ASTM A 1064.

C. Tie Wire:
   1. Standard tie wire: 16 gauge.
   2. Tie wire in contact with inside face of water-holding structures: 16 gauge SST.

D. Mechanical Threaded Connections:
   1. Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125% of yield strength of bar.

2.3 ACCESSORIES

A. Identification:
   1. Bundles of reinforcing bars and wire spirals:
      a. Tag with a metal tag.
      b. Show specification, grade, size, quantity, and suitable identification to permit checking, sorting, and placing.
      c. When bar marks are used to identify reinforcing bars on the Drawings, show bar mark on tag.
      d. Remove tags prior to concrete placement.
   2. Tag bundles of flat sheets of welded wire fabric similar to reinforcing bars.

B. Bar Supports:
   1. General:
      a. Bar supports and spacing shall be in accordance with CRSI Manual of Standard Practice, CRSI Class 1, plastic protected or Class 2 SST protected, Chapter 3 and shall be a maximum of 4 feet or as shown on the Drawings.
      b. Metal chairs: SST, zinc-coated steel, steel epoxy-coated after fabrication, or uncoated steel with approved plastic tipped legs with minimum 1/2 inch of the lower end of legs plastic-coated.
      c. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
      d. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter the movement of moisture from the surface to the reinforcement.
      e. Precast concrete supports shall have the same minimum strength and shall be made from the same materials as the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
      f. In beams, columns, walls, and slabs exposed to view after form removal use coated steel chairs.
      g. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
   2. Floor slabs:
      a. Use coated steel chairs in applications where the bottom of the slab will be exposed. Coated or uncoated steel chairs may be used in other applications.
      b. Composite chairs are not acceptable.
      c. When required, staple the chair onto a bearing pad:
         1) Exterior grade plywood: 1/4 inch thick.
         2) Approximately 5 inches square.
   3. Soffits:
      a. Steel wire bar supports where soffits are exposed to view or are painted shall be in accordance with CRSI Class 1 or Class 2, Types A or B.
      b. Steel wire bar supports where soffits are not exposed to view and not painted shall be in accordance with CRSI Class 3.
   4. Water and wastewater vaults, water storage tank and basin walls, columns and roof slabs:
      a. Walls and roof slabs: Use a plastic clip 100% epoxy-coated steel chair bar and bolster supports.
      b. Securely staple supports to the formwork.
      c. Nonmetallic composite chairs may be used if approved by the ENGINEER.

C. Mechanical Bar Splices:
1. Mechanical threaded butt connectors may be used in lieu of lapped splices when approved.
2. Mechanical connections shall be capable of developing a minimum of 125% of yield strength of reinforcing bar in both tension and compression.
3. Coat parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts with the same material used for the repair of coating damage.
4. Splicing system shall be in accordance with Type 2 tensile requirements of ACI 318.
5. Products shall have a current evaluation report verifying testing in accordance with ICC-ES AC 133.

2.4 FABRICATION
A. Fabrication tolerances for straight and bent bars shall be in accordance with ACI 315 and the CRSI Manual of Standard Practice.

2.5 FINISHES
A. Provide epoxy-coated reinforcement in accordance with ASTM A 775 as shown on the Drawings.

PART 3 EXECUTION

3.1 PREPARATION
A. Bending:
1. Reinforcing bars shall be bent cold to shapes shown on the Drawings and, unless otherwise approved, bends shall be in accordance with ACI 315 and ACI 318. Bending dimensions shall be out to out of bar.
2. Bars partially embedded in concrete shall not be field bent except as shown on the Drawings.
3. Bars shall not be bent or straightened in a manner that will injure the material.
4. Spirals:
a. 1 1/2 finishing bends are required at the top and bottom of the spiral.
b. Provide spacers in accordance with the CRSI Manual of Standard Practice.
c. Welding as an aid to fabrication or installation is not permitted.

B. The placing and securing of the reinforcement in any unit or section shall be accepted by the ENGINEER before any concrete is placed in any such unit or section.

3.2 INSTALLATION
A. Placing and Fastening:
1. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
2. Place, fasten, splice, and support reinforcing steel and wire mesh or bar mat reinforcement in accordance with the CRSI Recommended Practice for Placing Reinforcing Bars and as shown on the Drawings.
3. Place reinforcement within the tolerances in accordance with ACI 117.
4. When placed in the Work, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.
5. Accurately place steel reinforcement in the positions shown on the Drawings and hold firmly during the placing and setting of concrete by means of spacer strips, stays, metal chairs, or other approved devices or supports.
a. Space chair and bolster supports for slabs and walls at maximum 4 foot centers, unless otherwise shown on the Drawings.
b. Use bar steel reinforcement to support the top layers of reinforcing.
c. After form removal, clip the staple tails used to attach bar supports to the wall and roof form.
d. Provide one row of continuous bar chairs for support under each row of bar splices.
6. Tie bars securely at intersections, except where spacing is less than 1 foot in each direction, when alternate intersections shall be tied.
a. The tying of steel by spot welding is not allowed.
b. Bend tie wire to prevent tie wire from being closer than 1 inch from the surface of concrete.
c. Ties for use with coated reinforcement: Approved plastic-coated wire.
d. Bundle bars: Tie together at maximum 6 foot centers.
7. Adjust or relocate the reinforcement used in post-tensioned concrete during the installation of pre-stressing ducts or tendons to provide location and planned clearances to pre-stressing tendons, anchorages, jacks, and equipment as approved.
8. Use snap or single ties unless the tie fails to securely hold reinforcing steel. If the tie fails, saddle or U-tie at no additional expense to the OWNER.
9. Repair coating damage to epoxy-coated steel bars with a repair epoxy compatible with the base epoxy coating.
10. Surfaces encrusted with dried concrete from previous placements shall be cleaned.
11. Remove frost, ice, and snow before concrete is placed.

B. Splicing:
1. Bar steel reinforcement shall be furnished in full lengths as shown on the Drawings.
2. The splicing of bars, except where shown on the Drawings, is not permitted unless approved by the ENGINEER in writing.
3. Stagger splices at the minimum distance required for lapped splice in bar.
4. When permission is granted to splice bars, other than those shown on the Drawings, provide the additional material required for lap at no additional cost to the OWNER.
5. Splices will not be permitted at points where the section is not sufficient to provide a minimum distance of 2 inches between the splice and the nearest adjacent bar or surface of concrete.
6. Sheets of mesh or bar steel reinforcement shall overlap each other sufficiently to maintain uniform strength and shall be securely fastened at ends and edges. Minimum edge lap shall be 1 mesh in width.

7. The welding of reinforcement shall be done only if shown on the Drawings or if authorized by the ENGINEER in writing.
    a. Welded splices shall be direct butt splices.
    b. After completion of welding, repair coating damage to any epoxy-coated reinforcing steel bars.
    c. Test 4% of the total number of splices for each bar size, but no less than four splices, by radiographic methods.
8. When specifically shown on the Drawings or permitted in writing by the ENGINEER, a mechanical connection may be used to splice reinforcing steel bars or as a substitution for dowel bars.
    a. Install threaded rods as recommended by the Manufacturer with threads totally engaged into the coupling sleeve and in accordance with ICC-ES ESR or equivalent code agency report.
    b. For metal sleeve splice, follow the Manufacturer's installation recommendations.
    c. Maintain minimum edge distance and concrete cover.
9. Splices of lap reinforcement shall be full-contact splices.

C. Cutting: Unless permitted by the ENGINEER, do not cut reinforcing bars in the field. When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for the repair of coating damage.

D. Reinforcement Around Openings: On each side and above and below the pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond the opening at each end.

E. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

F. Mechanical Connections:
1. Use only in areas specifically shown or approved in writing by the ENGINEER.
2. Install threaded rods as recommended by the Manufacturer with threads totally engaged into the coupling sleeve and in accordance with ICC-ES ESR.
3. For metal sleeve splice, follow the Manufacturer's installation recommendations.
4. Maintain minimum edge distance and concrete cover.

3.3 QUALITY CONTROL

A. Quality control, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on the Drawings. The CONTRACTOR responsibilities and related information as specified in SECTION 01 40 00.

B. Reinforcing Steel Placement Review:
1. A minimum of 1 day prior to concrete placement, a final inspection of reinforcing steel placement for footings, slabs, columns, beams, and walls of structures will be performed by the ENGINEER.
2. Perform a quality control review prior to the ENGINEER's final review to determine the acceptability, completeness, and cleanup of any Subcontractor's Work and overall readiness of the Work for the final review.
3. If the CONTRACTOR has proceeded to place forms prior to the final review, remove sufficient forms to permit the visual inspection of the reinforcing steel and appurtenances such as reinforcing steel supports, chairs, and ties at no cost to the OWNER.

END OF SECTION

SECTION 03 24 00
FIBROUS REINFORCING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for fibrous reinforcing.
- B. Related Sections:
  1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 78 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
  2. C 1116 – Standard Specification for Fiber-Reinforced Concrete
  3. E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials

1.3 DEFINITIONS
- A. Fibrillated Fibers: Fibers in bundles that, when added to concrete during mixing, separate into uniformly distributed angular fibrils (fiber strands) which act as secondary concrete reinforcement.
- B. Macro-Fibers: Longer length, higher volume, typically 0.4% to 0.7% by volume fiber, sometimes referred to as structural fibers.
- C. Micro-Fibers: Shorter length, low dose, typically 0.1% by volume fibers designed to control plastic shrinkage cracking.

1.4 SUBMITTALS
- A. Action Submittals: Product data for fibrillated fibers.
- B. Informational Submittals:
  1. Manufacturer's written instructions for the mixing and batching of fibrillated fibers.
  2. The Fiber Manufacturer's certificate of compliance.
- C. Quality Assurance: Fibrous reinforcement requirements shall be in accordance with the AHJ. Jurisdictional requirements shall govern when in conflict with the Contract Documents.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Micro-Fibers:
  1. Euclid Chemical Company, Fiberstrand F
  2. Propex Concrete Systems Corporation, Fibermesh 300
- B. Macro-Fibers:
  1. Euclid Chemical Company, Tuf-Strand SF
  2. Propex Concrete Systems Corporation, Fibermesh 650
  3. W. R. Grace & Company, Strux 90/40

2.2 MATERIALS
- A. Performance Requirements:
  1. Minimum residual strength index of 50 psi.
  2. A 2-hour fire resistance rating when tested under ASTM E 119 on Series 700, Series 800, and Series 900 composite metal deck assemblies.
- B. Micro-Fibers:
  1. 100% virgin PP self-fibrillating fibers.
  2. Multi-design gradation.
  3. Fibrillated bundles to allow uniform distributed angular fibrils (fiber strands) when mixed into concrete.
  4. Specific gravity: 0.91 minimum.
  5. Reprocessed olefin materials are not allowed.
  6. Type III fibers in accordance with ASTM C 1116, Part 4.1.3.
  7. Fiber length: 1/2 inch to 1 inch.
- C. Macro-Fibers:
  1. PP/PE monofilament (single filament fiber).
  2. Specific gravity: 0.92 minimum.
  3. Tensile strength: 85 ksi minimum.
  4. Type III fibers in accordance with ASTM C 1116, Part 4.1.3.
  5. Aspect ratio: The ratio of length to diameter of the fiber shall be 70 minimum.
  6. Fiber length: 1 1/2 inches to 2 inches.
- D. Concrete Components: As specified in SECTION 03 30 00.

2.3 MIXES
- A. As specified in SECTION 03 30 00.
- B. Add 2 lbs minimum per cy at the time concrete is batched.
- C. Mix fibers into concrete in accordance with the Fiber Manufacturer's instructions.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Test as specified in SECTION 03 30 00.
- B. Test fiber reinforced concrete with a modified version of the ASTM C 78 test using Fibermesh's printed test procedure.
- C. Test a minimum of two beam samples prior to casting the concrete.
- D. Test a minimum of two additional beam samples for each 25 cy or any portion thereof used on the Project.
- E. Placing, protecting, curing, and finishing shall be as specified in SECTION 03 30 00.

3.2 QUALITY CONTROL

A. Provide a technical representative to instruct the Concrete Supplier in the proper batching and mixing of materials.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for cast-in-place concrete.

B. Related Sections:

1. SECTION 01 44 33 – MANUFACTURER'S SERVICES
2. SECTION 01 45 29 – MATERIALS TESTING
3. SECTION 03 11 00 – CONCRETE FORMING
4. SECTION 03 15 00 – CONCRETE ACCESSORIES
5. SECTION 03 15 05 – ANCHORING TO CONCRETE
6. SECTION 03 15 15 – HYDROPHILIC RUBBER WATERSTOP
7. SECTION 03 39 00 – CONCRETE CURING
8. SECTION 03 62 00 – NON-SHRINK GROUTING
9. SECTION 03 65 00 – CHEMICAL GROUTING
10. SECTION 09 90 00 – PAINTING AND COATING
11. SECTION 31 23 13 – SUBGRADE PREPARATION

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 117 – Specification for Tolerances for Concrete Construction and Materials
2. 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. 301 – Specifications for Structural Concrete
4. 305.1 – Specification for Hot Weather Concreting
5. 306.1 – Standard Specification for Cold Weather Concreting
6. 318 – Building Code Requirements for Structural Concrete

B. ASTM International (ASTM):

1. C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. C 33 – Standard Specification for Concrete Aggregates
3. C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C 42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. C 78 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam and Third-Point Loading)
6. C 88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
7. C 94 – Standard Specification for Ready-Mixed Concrete
8. C 127 – Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
9. C 128 – Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
10. C 143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
11. C 150 – Standard Specification for Portland Cement
12. C 157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
13. C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
14. C 260 – Standard Specification for Air-Entraining Admixtures for Concrete
15. C 295 – Standard Guide for Petrographic Examination of Aggregates for Concrete
16. C 311 – Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
17. C 330 – Standard Specification for Lightweight Aggregates for Structural Concrete
18. C 494 – Standard Specification for Chemical Admixtures for Concrete
19. C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
20. C 979 – Standard Specification for Pigments for Integrally Colored Concrete
21. C 1012 – Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
22. C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
23. C 1218 – Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
24. C 1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
25. C 1602 – Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
26. C 1761 – Standard Specification for Lightweight Aggregate for Internal Curing of Concrete
27. E 329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

C. International Code Council (ICC):

1. International Building Code (IBC), Chapter 17 – Special Inspections and Testing

D. National Institute of Standards and Technology (NIST):

1. Handbook No. 44 – Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

1.3 DEFINITIONS

A. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations, cracks 0.015 inch wide and larger, and cracks that leak in water-holding structures, spalls, chips, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, and other projections, form popouts, texture irregularities, and stains that cannot be removed by cleaning.

B. Field Test Data: Compressive strength data taken from concrete that is delivered and used for construction.

C. Lab Test Data: Compressive strength data taken from trial mixes produced in a laboratory.

D. New Concrete: Less than 60 days old.

1.4 SUBMITTALS

A. Product Data:
1. Portland cement.
2. Fly ash.
3. Admixtures.
4. Bonding agent.
5. Bond breaker.
6. Patching materials.

B. Quality Control Submittals:
1. The Manufacturer's application instructions for the bonding agent and the bond breaker.
2. Statements of qualification:
a. Mix designer.
b. Batch plant.
c. Epoxy injection installer.
d. Adhesive anchor installer certified by ACI as specified in SECTION 03 15 05.
e. Laboratory and personnel certifications for the CONTRACTOR's testing consultant as specified in SECTION 01 45 29, if the CONTRACTOR'S QC will include this testing.
3. Test reports:
a. Cement: Chemical analysis report.
b. Supplementary cementitious materials: Chemical analysis report and report of other specified test analyses.
c. Water-soluble chloride-ion content in hardened concrete: Unless otherwise permitted, in accordance with ASTM C 1218 at an age between 28 days and 42 days.
d. Admixtures: Test reports showing chemical ingredients and the percentage of chloride in each admixture and fly ash.
e. A source test analysis report for fly ash.
f. Each trial mix design shall be signed by a qualified mix designer.
g. Compressive strength data from laboratory mixes.
h. Compressive strength data from field tests. If field data for a proposed structural concrete mix is not available, compressive strength based on laboratory mix shall show an average compressive strength at least 1,200 psi above the required 28-day strength.
i. Documentation of average strength for each proposed mix design in accordance with ACI 301.
j. Shrinkage test results: In accordance with ASTM C 157 as modified herein.
k. Alkali aggregate reactivity: Aggregate shall be classified as nonpotentially reactive as specified in this Section. Include documentation of test results in accordance with applicable standards.
4. Concrete delivery tickets: In accordance with ASTM C 94 and as specified in this Section.
5. Daily minimum and maximum temperature readings at concrete surface during cold weather concreting operations.

C. Administrative Submittals: Pre-installation meeting minutes.

D. Material Submittals:
1. Design data: Concrete mix designs signed by a qualified mix designer.
2. Mix designs shall include the following information from the concrete producer for each mix design with planned admixture dosage rates:
a. Time from batch to initial set.
b. Drum revolutions allowed from batch time to discharge of concrete.
3. Aggregate: Gradation for coarse and fine aggregates.
4. Placement drawings: Concrete, identifying the location of each type of joint and placement sequence.
5. Detailed work plans:
a. Cold weather curing and the protection of concrete placed and cured in weather below 40ºF.
b. Hot weather placements including curing and the protection for concrete placed in ambient temperatures above 80ºF.
c. Pumping concrete, identifying the pump location and placing sequence.
6. Repair methods:
a. Water-holding structure.
b. Surface finish.
c. Honeycomb, rock pockets, and bug holes.
d. Application schedule and instructions for patching materials and blending to match adjacent concrete.
7. Colored concrete samples: Submit two cubes each, 2 inch by 2 inch by 2 inch, for three ENGINEER-selected colors from the Manufacturer’s standard color range, for final selection.
8. Manufacturer’s certificate of compliance:
a. Cement.
b. Aggregates.
c. Admixtures.
d. Fly ash.
e. Epoxy bonding agent.

1.5 QUALITY ASSURANCE

A. Concrete construction shall be in accordance with ACI 117 and ACI 301, except as modified herein.

B. Qualifications:

1. Mix designer:
    a. A licensed Professional Engineer or working directly for a licensed Professional Engineer registered in the State of Colorado.
    b. A minimum of 5 years of experience in the design of structural concrete mixtures.
2. Mix design: In accordance with ACI 301.
3. Batch plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
4. Testing agency: Unless otherwise permitted, an independent agency, acceptable to the AHJ, and qualified in accordance with ASTM C 1077 and ASTM E 329 for the testing indicated.

C. Pre-Installation Meetings:
1. Minimum attendance: CONTRACTOR, ENGINEER, Ready-Mix Producer, Admixture Representative, Testing and Sampling Personnel, Concrete Finishing Foreman, and Pump Truck Representative.
2. Schedule and conduct prior to the incorporation of respective products into the Work. Notify the ENGINEER in writing of the location and the time.
3. Minimum agenda:
    a. Admixture types, dosage, performance, and re-dosing at the site.
    b. Mix designs, test of mixes, and Submittals.
    c. Batch plant location(s) and expected drive time from plant to site.
    d. Placement methods, sequence, techniques, equipment, consolidation, and form pressures.
    e. Slump and placement time to maintain slump.
    f. Finish, curing, and water retention.
    g. Addition of water at the site.
    h. Mixing methods.
    i. Equipment requirements.
    j. Hot and cold weather protection.
    k. Other specified requirements that need coordination.
4. Prepare and submit minutes.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Finishing Aids:
1. Solomon Colors, Day1 Finishing

B. Shrinkage Reducing Admixture:
1. BASF, MasterLife SRA 035
2. Euclid, Eucon SRA
3. GCP Applied Technologies (Grace), Eclipse 4500
4. Sika Corporation, SikaControl 75

2.2 MATERIALS

A. Finishing/Trowel Aid: Topically applied colloidal silica compound. Do not use as a curing compound. Only to be used to assist in finishing by working into the surface immediately after application.

B. Cementitious Materials:
1. Cement:
    a. Type II portland cement in accordance with ASTM C 150.
    b. Site-specific soil may require cement that meets high sulfate resistance limits for Type V cement in accordance with Table 4 in ASTM C 150.
    c. Type III portland cement in accordance with ASTM C 150 meeting sulfate resistance necessary for site-specific soils is allowed for high-early strength mixes.
2. Fly ash:
    a. Class C or Class F fly ash in accordance with ASTM C 618, except that loss on ignition shall not exceed 3%. Class C shall also be qualified for moderate sulfate resistance as described in ASTM C 618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C 1012.
    b. Make fly ash additions to the mix on a cement substitution basis in accordance with ASTM C 618.
    c. The maximum allowable amount of fly ash shall be 20% by weight of total cementitious materials, unless otherwise specifically required in this Section.

C. Aggregates:
1. General:
    a. Furnish from one source.
    b. Natural aggregates:
        1) Free from deleterious coatings and substances in accordance with ASTM C 33, except as modified herein.
        2) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on the surface of concrete.
    c. Alkali reactivity of aggregates:
        1) In accordance with ASTM C 33.
        2) Tested for reactivity in accordance with ASTM C 1260.
        3) A maximum of 0.10% expansion at 16-day soak for any aggregate product used in portland cement concrete.
        4) Retest for reactivity every 6 months to reconfirm conformance and submit results to the ENGINEER.
    d. Aggregate soundness:

1) Test fine and coarse aggregates in accordance with ASTM C 33.
2) Test fine and coarse aggregates in accordance with ASTM C 88 using a sodium sulfate solution.
3) The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

2. Fine aggregate:
   a. Natural sand or a blend of natural sand and crushed sand.
   b. Crushed sand shall be less than 50% of the total sand by dry weight.
   c. Fine aggregate grading and quality shall be in accordance with ASTM C 33.
   d. Except where otherwise designated or approved, fine aggregates shall be a maximum of 45% by weight of the total aggregates in the concrete.
   e. Total materials passing No. 200 sieve: 3% maximum.
   f. Deleterious substances: In accordance with ASTM C 33, Table 1.
3. Lightweight fine aggregate:
   a. Expanded shale, clay, or slate lightweight aggregate produced by the rotary kiln method shall be in accordance with ASTM C 330 and ASTM C 1761.
4. Coarse aggregate:
   a. Natural gravels or crushed stone.
   b. Grading and quality requirements in accordance with ASTM C 33 for size No. 57, No. 67, or No. 467.
   c. Limit deleterious substances in accordance with ASTM C 33, Table 3 for exposed concrete.
   d. If the aggregates used are known to be reactive with high alkali cement, in accordance with ASTM C 295, or if reactivity of aggregates is not known, use low alkali cement in accordance with ASTM C 150, Table 2 to ensure adequate protection from a potential alkali-aggregate reaction.

D. Admixtures:
1. General:
   a. Furnish from one Manufacturer.
   b. Assume responsibilities for damage or difficulties occurring as result of the use of admixtures; additional compensation due to such difficulties is not permitted.
   c. The use of admixtures does not relieve the CONTRACTOR of the responsibility for the protection and curing of concrete.
   d. Compatible with other admixtures.
   e. Free of chlorides or other corrosive chemicals.
   f. Do not use calcium chloride.
   g. Use of admixture(s) without prior written authorization of the ENGINEER is cause for removal of concrete, at the sole discretion of the ENGINEER. This includes, but is not limited to, addition of admixtures on-site by the pump operator or other unauthorized personnel.
2. Air entraining admixture:
   a. In accordance with ASTM C 260, non-toxic after 30 days.
   b. Use an air entraining agent in concrete.
   c. Add to the batch in accordance with ASTM C 94.
   d. Maintain the air percentage as batched, within ±1.5%, for the time required for placement into the structure.
3. Water reducing admixtures: In accordance with ASTM C 494, Type A or Type D.
4. High range water reducing admixtures:
   a. Use only where specified or directed by the ENGINEER.
   b. In accordance with ASTM C 494, Type F or Type G.
   c. Use type in accordance with the Manufacturer's instructions for allowable temperature ranges.
5. Retarding admixture: In accordance with ASTM C 494, Type B.
6. Accelerating admixture: In accordance with ASTM C 494, Type C.
7. Concrete for ductbank: Contain 3 lbs of red oxide per 94 lb sack of cement.
8. Integral concrete coloring admixtures:
   a. In accordance with ASTM C 494 and ASTM C 979.
   b. Single-component packaged in cubic yard dosage increments.
   c. Concrete mix design to be coordinated and proportioned to meet the requirements of the coloring admixture, including compatibility with other mix design admixtures.
   d. Color: To be selected from the Manufacturer's standard color range.

E. Fibrous Reinforcing: As specified in SECTION 03 24 00 or the permitting jurisdiction.
F. Water: In accordance with ASTM C 1602.
G. Concrete Mix Design:
1. Design:
   a. Submit mix designs in accordance with ACI 301, Section 4.
   b. Mixture testing: Testing results shall be submitted for review and shall be acceptable to the ENGINEER before concrete Work is started.
   c. Field test record data:
      1) Concrete mixtures may be qualified based on field test record performance data.
      2) Field test record data shall be from the production facility being used on the current Project and shall have been performed in the past 9 months.
      3) Field test record data shall represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days.

4) Proposed mix design proportions based solely on trial mixtures shall be accompanied by clear written justification for use and are only permitted with the written approval of the ENGINEER.

d. w/cm: Control allowable water addition to the mix; do not exceed w/cm ratio.

e. Fibrous reinforcement: Use in mixes as specifically required in the Contract Documents or by the permitting jurisdiction for ROW.

f. High-early strength concrete:
   1) If the CONTRACTOR prefers to use a high-early strength concrete for scheduling purposes, adjustments to the following mix designs are acceptable only with the written approval of the ENGINEER.
   2) Provide specific methods for curing as specified in SECTION 03 39 00 to limit temperature and shrinkage cracking caused by higher heat of hydration caused by high-early strength concrete.

2. Mixes:
   a. Structural internally cured concrete:
      1) For use as structural concrete on post-tensioned water bearing structures.
      2) Minimum 28-day compressive strength: 4,500 psi when molded and cured in accordance with ASTM C 31.
      3) Minimum cementitious content: 615 lbs/cy to 660 lbs/cy.
      4) Maximum w/cm ratio: 0.45.
      5) Slump:
         a) 3 inches to 6 inches when measured in accordance with ASTM C 143 when no high range water reducing admixture is used.,
         b) 4 1/2 inches to 8 inches when measured in accordance with ASTM C 143 when a high range water reducing admixture is used.
      6) Air content:
         a) 5% to 8% of volume of batch when tested in accordance with ASTM C 231.
         b) Maximum of 3% air content for interior floor slabs where a steel troweled (Type S-1) or a sealer/hardener concrete floor finish is specified.
      7) Design to meet shrinkage limits of 0.04% in accordance with ASTM C 157.
      8) Maximum fly ash content: 20%.
      9) Coordinate with the Lightweight Aggregate Supplier to determine the volume of normal weight fine aggregate that will be substituted with lightweight fine aggregate for the specific material. Lightweight aggregate shall be pre-conditioned to a minimum moisture content equal to or greater than the desorption value of the aggregate before batching the concrete. Testing of moisture content shall be in accordance with ASTM C 127 or ASTM C 128.
   b. Structural concrete non-internally cured concrete (CDOT Class D):
      1) For use as structural concrete on non-water bearing structures.
      2) For use as ductbank, and other non-structural components that may be exposed to moisture and freeze-thaw cycles.
      3) Minimum 28-day compressive strength: 4,500 psi when molded and cured in accordance with ASTM C 31.
      4) Minimum cementitious content: 615 lbs/cy to 660 lbs/cy.
      5) Maximum w/cm ratio: 0.45.
      6) Slump:
         a) 1 1/2 inches to 4 inches when measured in accordance with ASTM C 143 when no high range water reducing admixture is used.
         b) 4 1/2 inches to 8 inches when measured in accordance with ASTM C 143 when a high range water reducing admixture is used.
      7) Air content:
         a) 5% to 8% of volume of batch when tested in accordance with ASTM C 231.
         b) Maximum of 3% air content for interior floor slabs where a steel troweled (Type S-1) or a sealer/hardener concrete floor finish is specified.
      8) Design to meet shrinkage limits of 0.04% in accordance with ASTM C 157.
      9) Concrete for ductbanks shall contain 3 lbs of red oxide per 94 lb sack of cement.
   c. Concrete fill (Class B):
      1) For thrust blocks or as lean concrete when approved by the ENGINEER.
      2) Minimum 28-day compressive strength: 2,500 psi when molded and cured in accordance with ASTM C 31.
      3) Minimum cementitious content: 400 lbs/cy.
      4) Maximum w/cm ratio: 0.62.
      5) Air content: 4% to 8% of the volume of the batch when tested in accordance with ASTM C 231.
   d. Pavement concrete (modified Class P):
      1) Minimum 28-day compressive strength: 4,500 psi when molded and cured in accordance with ASTM C 31.
      2) Minimum Type II portland cement content of 528 lb/cy of concrete.
      3) Maximum w/cm ratio: 0.44.
      4) Maximum slump for hand placed concrete: 4 inches.
      5) Air content: 5% to 8% of volume of batch when tested in accordance with ASTM C 231.
      6) Minimum 28-day flexural strength of 650 psi in accordance with ASTM C 78.
      7) Fibrous reinforcement as required by the permitting jurisdiction.
   e. Mass concrete:
      1) Requires a project-specific mix design provided by a Professional Engineer.
      2) A minimum of 30% Class F fly ash or a low alkali, moderate to high sulfate resistant cement.

3. Proportions:
    a. Design the mix to meet aesthetic and structural concrete requirements.
    b. Proportion the mix in accordance with ACI 211.1, unless specified otherwise.

2.3 ACCESSORIES

A. Crack Repair Epoxy: As specified in SECTION 03 65 00.

B. Bonding Agent: Two-component type in accordance with the Manufacturer's instructions for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.

C. Bond Breaker: As specified in SECTION 03 15 00.

D. Patching Material:
1. Free from chlorides and other chemicals causing steel corrosion.
2. Match the color and texture of adjacent concrete.

PART 3 EXECUTION

3.1 GENERAL

A. Placement Specifications:
1. Maximum size of concrete placements:
    a. Limit the size of each placement to allow for strength gain and volume change due to shrinkage.
    b. Construction joints:
        1) Place joints at locations shown on the Drawings at a minimum.
        2) Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
        3) Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.
        4) Provide where shown on the ENGINEER-reviewed placement Drawings and in accordance with the Contract Documents.
        5) The location, size, and configuration of construction joints will be subject to the acceptance of the ENGINEER.
        6) Space joints to limit the size of placements to allow for volume change from shrinkage and to minimize the potential of restraint and shrinkage cracking.
        7) For slabs that require construction joints:
            a) The method of alternating long strip placements shall be used.
            b) Checkerboarding of slabs is not permitted without the written approval of the ENGINEER.
        8) No horizontal joints are permitted in the walls of water-holding structures.
        9) No horizontal joints are permitted in slabs, beams, or other horizontally oriented structural members.
        10) Keyways:
            a) Keyways shall only be permitted if the specific joint has been designed by a Professional Engineer accounting for element design and loading conditions and approved in writing by the OWNER.
            b) Key construction joints shown on the Drawings at a right angle to the direction of shear.
            c) Except where otherwise shown on the Drawings, keyways shall be a minimum of 1 1/2 inches in depth over at least 25% area of the section.
            d) Consider beams, girders, brackets, column capitals, and haunches as part of the floor or roof system and place monolithically with the floor or roof system.
            e) Install a waterstop in the joint if the placement sequence results in a cold joint located below a finished water surface, if the structure is a water-holding structure, or if the structure is in contact with water (interior or exterior).
2. Minimum time between adjacent placements:
    a. Do not place adjacent concrete until previously placed concrete has attained 100% of the approved submitted 28-day compressive strength as determined by field cylinders, or 7 days, whichever is shorter.
    b. Notify the ENGINEER in writing if adjacent placements are planned for earlier than the 7-day interval so that field cylinders can be taken from a previous placement for verification of the strength requirements.
3. Hot weather:
    a. In accordance with ACI 305.1.
    b. Maintain concrete temperature below 90°F at time of placement.
    c. Ingredients may be cooled before mixing. The method of cooling concrete shall be in accordance with ACI 305.1 and approved by the ENGINEER.
    d. When the rate of surface evaporation approaches 0.20 lbs/sf/hr for non-fly ash concrete mixes, and 0.15 psf/hr for concrete mixes containing more than 15% fly ash as estimated by the ENGINEER in accordance with ACI 305.1, Figure 2.1.5, make provisions for windbreaks, shading, fog spraying, sprinkling, ice, or wet cover as required by the ENGINEER before and during concrete placement.
    e. If the rate of evaporation approaches 0.20 lbs/sf/hr in accordance with ACI 305.1, precautions against plastic shrinkage are required.
    f. Provide a recording thermometer, hygrometer, and wind gauge in operating condition on-site 7 days prior to the first concrete placement.
    g. Precautions against plastic shrinkage cracks may be required in conditions other than what are normally considered hot weather conditions.
    h. If reinforcement is in direct sunlight or is more than 20°F higher in temperature than the concrete temperature before placement, wet the reinforcement with a water fog spray before placing concrete to cool the reinforcement.

i. Do not cool plastic concrete mixtures without the approval of the ENGINEER.
j. Evaporation retardant: As specified in SECTION 03 39 00.

4. Cold weather:
   a. Do not place concrete against frozen earth or ice, or against forms and reinforcement with frost or ice present.
   b. Prevent carbonation on unprotected new concrete surfaces.
   c. In accordance with ACI 306.1, including maintaining the temperature of concrete as specified.
   d. Provide maximum and minimum thermometers placed on concrete surfaces and spaced throughout Work to allow the monitoring of concrete surface temperatures that are representative of the Work. Monitor and record the minimum and maximum temperatures at least four times per day.
   e. Maintain concrete temperature above 55°F at the time of placement.
   f. Provide cold weather protection when air temperatures are below 40°F.
   g. Supplemental heating units:
      1) Heated enclosures may be required to keep ambient air temperatures at the concrete surface above 55°F.
      2) Ensure the enclosure shall be strong enough to be windproof and weatherproof to maintain proper temperatures at corners, edges, and in thin sections.
      3) Consider that the concrete heat of hydration may heat the enclosure for the first 24 hours to 48 hours after placement without a heating unit.
      4) Do not cause excessive heating of ambient air temperatures at the concrete surface by use of a heating unit. Maximum ambient air temperature due to a heating unit shall be 70°F.
      5) Electric heaters, hydronic heaters, and indirect fired heaters (exhaust is separate from hot air and only clean air discharges in the enclosed workspace) are permitted as heating units.
      6) Combustion heating units shall be vented to the atmosphere and are not permitted to locally heat or dry concrete.
      7) Hydronic heaters:
         a) Cover concrete in PE film as specified in SECTION 03 39 00.
         b) Place serpentine heat transfer hoses evenly throughout the enclosure and on top of PE film.
         c) Place insulating concrete blankets over heat transfer hoses to create a heated enclosure.
   h. Protection period:
      1) Cold weather protection shall remain in place until concrete has attained a minimum compressive strength of 3,500 psi as determined by field cylinders, or 7 days, whichever is shorter.
      2) Removal of protection shall allow the concrete surface to cool gradually. For concrete members less than 36 inches thick, the concrete surface shall not be allowed to cool more than 40°F in 24 hours.
      3) For concrete members thicker than 36 inches, consult with the ENGINEER for specific protection removal requirements.
   i. Do not warm plastic concrete mixtures without the approval of the ENGINEER.
   j. Maintain curing conditions as specified in SECTION 03 39 00.

3.2 PREPARATION

A. General:
   1. Place concrete in the presence of the ENGINEER.
   2. In accordance with ACI 301, except as modified herein.
   3. Secure reinforcement in position before placing concrete.
   4. Clean form surfaces and embedded items of foreign material prior to placing concrete.
   5. Remove water and debris from spaces to be occupied by concrete.
   6. Inspection:
      a. Notify the ENGINEER in writing at least 2 days in advance of concrete placement.
      b. Do not place concrete until forms, reinforcing steel, and cleanup methods have been approved by the ENGINEER.
      c. Notify the ENGINEER in writing when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Concrete Mixing:
   1. Ready-mixed concrete: In accordance with ASTM C 94.
   2. The production inspection and the OWNER's QA testing of an approved mix will be made by the ENGINEER.
   3. Do not make changes in the amounts or sources of approved mix ingredients without the written approval of the ENGINEER.
   4. Concrete mix temperatures: In accordance with ACI 306.1 (cold weather) and ACI 305.1 (hot weather).
   5. Reverse the rotation on the drum of truck mixers to discharge wash water prior to charging mixer.
   6. Add admixtures in accordance with ASTM C 94 and the Manufacturer's instructions.
   7. Furnish an electronically generated batch ticket with each truck; concrete delivered without a batch ticket will be rejected.
      a. Deliver digital copy of batch tickets to the ENGINEER.
      b. Provide access for the ENGINEER to batch tickets at all times during placements and retain a copy for the record.
   8. Include the following minimum information on batch tickets:
      a. Supplier's name and date.
      b. Truck number.
      c. Project name and location.
      d. Concrete class designation.

e. Cubic yards batched.
f. Time batched.
g. Mix design number.
h. Type, brand, and quantity of each admixture.
i. Type, brand, and quantity of cement and fly ash.
j. Weights of fine and coarse aggregates.
k. Moisture of fine and coarse aggregates.
l. Gallons of water batched (including ice).
m. Allowable gallons of water added to reach w/cm ratio.

9. Add the following information to the batch ticket at the placement site:
   a. Gallons of water added by the truck operator shall not exceed the total amount of trim water to meet the maximum w/cm ratio in accordance with the submitted mix design.
   b. Number of revolutions of the drum at mixing speed.
   c. Discharge time.
   d. Location of batch in the placement.

3.3 INSTALLATION

A. Concrete Placement:

1. Discharge time and temperature:
   a. A maximum drum revolution and time from batch time to discharge shall not exceed the concrete supplier's limits as defined in the Submittal and in this Section. Exceeding these limits shall be cause for rejection of concrete.
   b. Concrete at or above 90°F prior to discharge shall be rejected.
   c. Coordinate information with the Admixture Manufacturer and the ENGINEER prior to placing concrete.
2. Placement into formwork:
   a. Concrete shall not be placed on frozen subgrade.
   b. Prior to the placement of concrete:
      1) Dampen and densify subgrade under the concrete as specified in SECTION 31 23 13.
      2) Dampen wood forms.
   c. Place concrete as soon as possible after leaving the mixer.
   d. Place concrete without segregation or loss of ingredients.
   e. Place concrete without splashing forms or the steel above.
   f. Place concrete in layers that are not over 24 inches in depth, except place slabs full depth.
   g. Place and consolidate successive layers of concrete prior to the initial set of the first layer to prevent cold joints. Ensure lifts are vibrated across lift lines.
   h. Place concrete so that plastic concrete flows readily between reinforcing steel and other embedded items.
   i. Do not place concrete that has partially hardened or is contaminated by foreign materials.
   j. Use placement devices including chutes, pouring spouts, and pumps.
   k. Concrete placed on slopes shall be placed from the bottom of slope up.
   l. Vertical free fall drop to final placement:
      1) 5 feet in forms.
      2) For placements where drops are greater than the specified distance, use a placement device so that free fall below the placement device conforms to the required value.
      3) Limit free fall to prevent segregation caused by aggregates hitting reinforcing steel or other embedded items.
      4) Ensure waterstop remains perpendicular to concrete surface.
   m. Do not use aluminum conveying devices.
   n. Provide illumination of the interior of the forms so the interior spaces of the forms are visible.
   o. Waterstop:
      1) Ensure the space beneath the plastic waterstop completely fills with concrete.
      2) During concrete placement, make visual inspection of the entire waterstop area.
      3) Each waterstop shall be continuous throughout the length of the joint in which it is installed.
      4) Junctions between adjacent sections of metal waterstops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.
      5) Junctions between adjacent sections of elastomeric (PVC) waterstops shall be spliced in strict conformity with the recommendations of the Manufacturer. Directional changes and intersection shall be factory fabricated by the Waterstop Manufacturer prior to delivery to the site of the Work.
      6) Field splices will be acceptable only in straight sections.
      7) Waterstop shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted.
      8) Limit concrete placement to the elevation of the waterstop in the first pass, vibrate concrete under the waterstop, and lift the waterstop to confirm full consolidation without voids; place remaining concrete to the full height of the slab.
      9) Apply procedure to the full length of waterstops.
   p. Prevent the accumulation of water on the surface of concrete due to water gain or other causes during placement and consolidation by making adjustments in the mix design.
   q. Round off the top exposed edges of walls with a 1/4 inch radius steel edging tool.

3. Conveyor belts and chutes:
    a. Design and arrange the ends of chutes, hopper gates, and other points of concrete discharge throughout the conveyance, the hoisting, and the placing system to allow for concrete to pass without becoming segregated.
    b. Do not use chutes longer than 50 feet.
    c. Angle chutes to allow concrete to readily flow without segregation with as little slope as possible.
    d. Conveyor belts:
        1) Approved by the ENGINEER.
        2) Wipe clean with a device that prevents mortar from adhering to the belt.
        3) Cover conveyor belts and chutes.
4. Addition of water at the site:
    a. Permitted only before any concrete is dispensed.
    b. Do not exceed w/cm ratio of submitted and approved mix design.
    c. Water additions shall be annotated, with quantities, on batch tickets.
    d. If hydration stabilizing admixtures are used, submit the brand, type, and anticipated dosage rates to the ENGINEER prior to placement.
    e. Provide an accurate means to determine and measure the volume of water added to the mix.
5. Pumping of concrete:
    a. Provide a standby pump, conveyor system, crane, and concrete bucket, or other system on-site during pumping, for adequate redundancy to ensure the completion of concrete placement without cold joints in the event of a primary placing equipment breakdown.
    b. Minimum pump hose (conduit) diameter: 4 inches.
    c. When needed, a tremie pipe may be used at the end of the pump hose. The tremie may be smaller than 4 inches to get through the reinforcing steel.
    d. Replace non-functioning and improperly functioning pumping equipment and hoses (conduits).
    e. Limit the pumping distance to 300 feet maximum.
    f. Use of admixture(s) without the prior written authorization of the ENGINEER is cause for removal of concrete, at the discretion of the ENGINEER.
        1) This includes, but is not limited to, the addition of admixtures on-site by the pump operator or other unauthorized personnel.
        2) In the case where an additive has been introduced to the concrete mix at the truck chute or pump hopper, the concrete in the hopper shall be wasted and an additional 0.5 cy shall be run through the pump and wasted before any further concrete is to be used in structure.
6. Consolidation and visual observation:
    a. Consolidation equipment and methods: In accordance with ACI 301.
    b. Provide the proper size, type, and number of vibrators to be used for each concrete placement.
    c. Consolidate concrete with internal vibrators with a minimum frequency of 8,000 cycles per minute and amplitude required to consolidate concrete in the section being placed.
    d. Provide a minimum of one standby vibrator for every two vibrators in operable condition at the placement site prior to placing concrete.
    e. Provide windows in forms or limit the form height to allow for concrete placement through windows and for the visual observation of concrete.
    f. Do not use vibration (consolidation) to move concrete laterally within forms.
    g. Where concrete is placed on a slope, do not use vibration to move the concrete down the slope.
    h. Vibrate concrete in the vicinity of joints to obtain impervious concrete.
    i. Thoroughly work concrete around reinforcing steel and other embedded items and into the corners of forms.
    j. Supplement vibrators by spading, rodding, or forking to eliminate honeycombing at the form face and voids around embedded items.
    k. Penetrate vibrator a minimum 6 inches into previous lift.
7. Finishing/trowel aid:
    a. Finishing/trowel aid shall be used on horizontal surfaces defined in the Contract Documents at a minimum. The product may be used on other horizontal surfaces at the CONTRACTOR's discretion.
    b. Finishing/trowel aid shall be applied directly in front of float or trowel operations and shall be finished into the surface immediately.
8. Curing: As specified in SECTION 03 39 00.

B. Joints:
1. Surface preparation:
    a. Mechanically roughen concrete to produce a minimum roughness profile of 1/4 inch.
    b. Hydrophilic waterstops shall be as specified in SECTION 03 15 15.
    c. Clean the surface of concrete construction joints and remove materials that inhibit bonding.
    d. Wet existing concrete surfaces with clean potable water and saturate for 1 day prior to placing new concrete.
    e. Remove standing water immediately before new concrete is placed.
    f. Expose clean aggregate by abrasive blast cleaning; wire brushing and air water jets may be used while concrete is fresh provided the results are equal to abrasive blast cleaning.
2. Wall horizontal construction joints in reinforced concrete walls containing waterstop:
    a. Prior to placing concrete, apply grout for horizontal construction joints. Grout shall be same as concrete mix for wall with maximum 3/8 inch nominal aggregate size.

b. Use a positive measuring device, such as a bucket or other device that will contain only enough sand-cement grout, for depositing in one place in the wall to ensure that portion of the form does not receive too much grout.
c. Limit grout placement to a 4 inch maximum thickness, 2 inch minimum thickness.
d. Do not deposit grout from pump hoses or large concrete buckets unless inspection windows near the joint are available to allow for a visual measurement of the grout thickness and a means for excess grout overflow is available.
e. Limit concrete placed immediately on top of grout to 12 inches thick. Thoroughly vibrate to mix concrete and grout together.

3. Pavement joints shall be located as shown on the Drawings. Maximum allowable joint spacing in pavement is twenty times the pavement thickness, or 14 feet, whichever is less.
4. Expansion joints for curb and gutter:
   a. Formed at uniform intervals of 80 feet, maximum.
   b. Made using 1/2 inch preformed filler as specified in SECTION 03 15 00.
   c. Place:
      1) Between the concrete curb and any fixed structure or bridge.
      2) Between the existing curb and the curb being replaced.
      3) Opposite expansion joints in concrete pavements.
5. Joints for sidewalks:
   a. Construct joints true to line with faces perpendicular to the surface.
   b. Expansion joint material shall be in place prior to the placing of concrete and shall be provided:
      1) At each end of the curb return.
      2) Between sidewalk and driveway slabs or service walks.
      3) Between new and existing concrete.
      4) Between new concrete and fixed vertical objects.
      5) As shown on the Drawings.
      6) As directed.
   c. Thoroughly clean surfaces prior to the installation of caulking material.
   d. Contraction (control) joints:
      1) Tooled: Walks shall be tool cut to a depth of 1/4 the slab thickness; space joints equal to the width of the walk; do not exceed 10 feet unless approved by the ENGINEER.
      2) Saw cut: Utilize power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8 inch wide joints into sufficiently hardened concrete so the cutting action will not tear, abrade, or damage the surface, but before the development of random contraction cracks. Saw cut joints shall be spaced at a distance equal to the width of the walk; do not exceed 10 feet unless approved by the ENGINEER. The depth of the joints shall be 1/4 the slab thickness.
6. Construction review:
   a. The ENGINEER will review the preparation of construction joints prior to concrete placement.
   b. Provide a minimum of 1 days' notice to the ENGINEER for review.
   c. If joint placement is performed without the ENGINEER present, Work will be deemed unacceptable and non-conforming.
   d. If the ENGINEER determines the construction review of a particular activity is unnecessary, the ENGINEER will provide written direction to the CONTRACTOR to proceed with that particular activity without construction review.

C. Section Length for Curb and Gutter:
1. Curb and combination curb and gutter shall be constructed in sections having a uniform length of 10 feet.
2. Sections of replacement curb or combination curb and gutter shall be equal to the length of existing curb or combination curb and gutter.
3. Sections shall be separated by a minimum of 1/8 inch wide by 1 inch deep-tooled control joints, except where expansion joints occur.

D. Finishing of Sidewalk Concrete:
1. After darbying or bullfloating, stop concrete finishing until bleeding ceases and concrete can support foot pressure with 1/8 inch indentation. During or after the first floating, check the planeness of the surface with a 10-foot straight edge applied at two or more different angles. Cut down high spots and fill low spots to achieve a true plane within 1/8 inch in 10 feet.
2. Refloat slab immediately to a uniform sandy texture. Use a steel trowel to smooth the surface; apply a medium broom finish to the slab perpendicular to the line of travel.
3. Handicap ramps:
   a. Provide score joints in handicap ramps that meet ADA standards.
   b. Install truncated dome inserts flush with the adjacent ramp surface taking care to achieve a tight bond with the concrete that is free of air pockets.
4. Carefully remove forms after the concrete surface is hard enough to prevent injury. Repair minor defects with mortar. Plastering is not permitted on exposed faces.

E. Pipe Penetrations: Unless otherwise shown on the Drawings, completely remove coatings, such as tape coating or paint and other materials that can inhibit bonding from the portion of pipe that is to be in contact with concrete.

F. Patching:
1. General:
   a. Inject cracks with crack repair epoxy as specified in SECTION 03 65 00.

b. Prior to beginning patching Work, obtain quantities of color-matched patching material and the Manufacturer's instructions for use.
c. Provide a structural patch with a finish to match the adjacent surface.
d. Dress the surface of patches that will remain exposed to view to match the color and texture of adjacent surfaces by using supplemental materials furnished by the Manufacturer for such purposes or by rubbing the area until a match is obtained.
e. Patch concrete to provide a structurally sound surface finish that is uniform in appearance.
f. Repair surface defects including fins, tie holes, and honeycombed areas down to solid concrete in accordance with ACI 301.

2. Tie holes:
a. Fill with Category I or II grout as specified in SECTION 03 62 00, except where sealant is shown on the Drawings; use only enough water to dry pack.
b. For areas exposed to view and not receiving a sack-rubbed finish, blend to the color and texture of the adjacent concrete.
c. Compact grout using a steel hammer and a steel tool to drive grout to high density.
d. Cure grout for 7 days at a minimum.

3. Alternate form ties-through-bolts:
a. Seal the through-bolt hole by sand blasting or mechanically cleaning and roughening the entire interior surface of the hole.
b. Epoxy coat the roughened surface.
c. Drive elastic vinyl plug and then dry pack the entire hole on each side of the plug with Category II grout as specified in SECTION 03 62 00. Use only enough water to dry pack the grout.
d. Dry pack while the epoxy is still tacky or remove the epoxy by mechanical means and reapply new epoxy.
e. Compact grout using a steel hammer and a steel tool to drive grout to high density.
f. Cure grout for 7 days at a minimum.

4. Defective areas: Repair as specified in SECTION 03 93 00.

5. Blockouts at penetrations:
a. Conform to the details shown on the Drawings or submit proposed blockouts for the review and approval of the ENGINEER.
b. Use non-shrink, nonmetallic grout, Category I or II as specified in SECTION 03 62 00.

G. Backfill Against Walls:
1. Do not backfill against walls until concrete has attained 100% of the approved submitted 28-day compressive strength as determined by field cylinders.
2. Notify the ENGINEER in writing when field cylinders are needed to determine when backfilling is allowed.
3. Place backfill simultaneously on both sides of the wall, where required, to prevent differential pressures.

H. Anchoring to Concrete: As specified in SECTION 03 15 05.

3.4 PROTECTION

A. After curing, as specified in SECTION 03 39 00, and after applying final floor finish, cover slabs with plywood, particle board, plastic sheeting, or other material to keep the floor clean and protect it from material and damage due to other construction Work.

B. Patch and repair defective areas and areas damaged by construction.

3.5 QUALITY CONTROL

A. General:
1. Any testing required for the permitting jurisdiction shall be provided by the CONTRACTOR.
2. Field testing for the OWNER's QA will be performed by the OWNER.
3. Provide access, cooperation, and incidental labor required by the QA and QC testing firms to obtain specimens, perform tests, and conduct inspections.
4. Provide facilities for safe storage and the proper curing of concrete test cylinders on-site for the first 2 days, and for additional time as required.
5. Provide concrete for the testing of slump, air content, and for making cylinders from the mixer truck chute.
6. When concrete is pumped, take samples from the discharge end of the truck mixer chute prior to the concrete entering the pump hopper.
7. Evaluation will be in accordance with ICC IBC, Chapter 17 and the Contract Documents.
8. Specimens will be made, cured, and tested in accordance with ASTM C 31 and ASTM C 39.
9. The frequency of testing for the OWNER's QA shall be at the discretion of the ENGINEER.
10. Assist in obtaining samples and provide undisturbed testing areas with 120 VAC power and access to water.

B. Compression Test Specimens:
1. Tests will be performed by the ENGINEER.
2. One set of concrete test cylinders shall be cast for each concrete pour. A set of test cylinders shall consist of a minimum six 4 inch diameter cylinders. One cylinder shall be tested at 7 days, three 4 inch diameter cylinders shall be tested at 28 days. The remaining two cylinders shall be held for tests at 56 days when required.
3. Notify the ENGINEER prior to concrete placement if field cylinders are required to verify in-place concrete strength for accelerated construction activities.

C. Enforcement of Strength Requirements:
1. If the strengths shown by laboratory cured test cylinders that are made and tested in accordance with the provisions of the ASTM Standard Specifications and evaluated by methods in accordance with ACI 318 fall below specified values, the ENGINEER may require changes in the proportions of concrete mix used on the remainder of Work.

2. The ENGINEER may require the CONTRACTOR to provide a minimum of three cores, drilled in accordance with ASTM C 42 and tested for compressive strength in accordance with ASTM C 39, for each portion of Work in which laboratory cured concrete test cylinders indicate a failure to meet the specified strength requirements within the specified time period.
3. The ENGINEER may require the CONTRACTOR to remove and replace areas determined to be defective.
4. Costs associated with additional testing and/or removal and replacement of concrete due to low strength tests shall be at the CONTRACTOR's expense.

D. Tolerances:
1. Form tolerances for wall, slabs, beams, and columns as specified in SECTION 03 11 00.
2. Walls: Measure and inspect walls for compliance with tolerances specified in SECTION 03 11 00.
3. Slabs:
a. Floor flatness measurements shall be made the day after the floor is finished and before shoring is removed, to eliminate the effects of shrinkage, curing, and deflection.
b. Support a 10-foot straight edge at each end with steel gauge blocks of thicknesses equal to the specified tolerance.
c. Compliance with designated limits in four of five consecutive measurements is satisfactory unless defective conditions are observed.

E. Test cement for total chloride content.

F. Test fly ash in accordance with ASTM C 311.

G. Batch Plant Inspection:
1. Provide access for the OWNER and the OWNER’s Representatives to inspect batch plants, cement mills, and supply facilities for products.
2. Weighing scales: Tested and certified within tolerances in accordance with NIST Handbook No. 44.
3. Batch plant equipment: Semi-automatic or fully automatic in accordance with ASTM C 94.
4. Central mixed concrete only in accordance with ASTM C 94.

H. Manufacturer’s Services: Provide the following representatives at the site as specified in SECTION 01 44 33, for installation assistance, inspection, and the certification of proper installation for concrete ingredients, mix design, mixing, and placement.
1. Batch plant representative:
a. Observe how concrete mixes are performing.
b. Observe the first placement of each type of concrete mix.
c. Assist with the concrete mix design, performance, placement, weather problems, and problems with concrete mix throughout the Work.
d. Establish control limits on concrete mix designs.

3.6 CAST-IN-PLACE CONCRETE SCHEDULE

A. Concrete Finishes:
1. Concrete walls:
a. Type W-1, ordinary wall finish:
1) Patch tie holes.
2) Knock off projections.
3) Patch defective areas.
b. Type W-2, finish for water bearing surfaces:
1) Fill cracks by epoxy injection. Repair cracks ≥ 0.005 inch and wider. Products and means of repair require Submittal and review.
2) Grout tie holes.
3) Knock off projections.
4) Repair defective areas. Products require Submittal and review.
c. Type W-3, smooth wall finish:
1) Fill cracks in water bearing surfaces by epoxy injection. Repair cracks ≥ 0.01 inch and wider. Products and means of repair require Submittal and review.
2) Patch tie holes.
3) Grind off projections, fins, and rough spots.
4) Patch defective areas and repair rough spots resulting from a form release agent failure or other causes to provide a smooth, uniform appearance.
d. Type W-5, finish for painting:
1) Fill cracks in water bearing surfaces by epoxy injection.
2) Patch tie holes.
3) Grind off projections, fins, and rough spots.
4) Patch and repair defective areas as specified for Type W-3.
5) Leave the surface ready for painting as specified in SECTION 09 90 00.
e. Type W-12, sack-rubbed finish:
1) Fill cracks by epoxy injection. Products and means of repair require Submittal and review.
2) Immediately after removing forms, form ties shall be broken back a minimum of 3/4 inch from the surface.
3) Honeycomb, voids, tie holes, and other surface defects shall be grouted.
4) The surface shall be thoroughly dampened and rubbed with a No. 16 carborundum stone or equal abrasive to create a uniform surface paste.

5) Continue rubbing until form marks and surface irregularities are removed and there is a smooth dense surface.
6) After setting, the surface shall be rubbed with a No. 30 carborundum stone until the defective areas and rough spots resulting from a form release agent failure or other causes to provide a smooth, uniform texture and color.
7) Grout: Mixed with one part portland cement and one and one-half parts fine sand and bonding agent to produce grout with the consistency of thick paint.
8) Substitute white portland cement for part of the gray portland cement to produce a color matching the color of the surrounding concrete, as determined by a trial area.
9) Wet the surface of the concrete sufficiently to prevent the absorption of water from the grout and to apply the grout uniformly with brushes or a spray gun.
10) Immediately after applying grout, scrub the surface vigorously with cork float or stone to coat the surface and fill air bubbles and holes.
11) While grout is still plastic, remove excess grout by working the surface with rubber float, burlap, or other means.
12) After the surface whitens from drying, about 30 minutes at 70°F, rub vigorously with clean burlap.
13) Cure the wall for 7 days.
14) Latex bonding admixture may be used.

2. Concrete slabs:
   a. General:
      1) Do not use jitterbugs or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar to accumulate.
      2) Do not dust surfaces with dry materials.
      3) Round off edges of slabs with a steel edging tool, except where cove finish is shown on the Drawings.
      4) Provide a steel edging tool radius of 1/4 inch for slabs subject to wheeled traffic.
      5) Use evaporation retardant only where specifically approved by the ENGINEER. Where approved for use, follow the Manufacturer's instructions and precautions. Evaporation retardant shall not be worked into concrete surface.
      6) Do not apply water to the concrete surface during any phase of finishing operations.
      7) Do not perform concrete finishing while water is present on the surface.
      8) Finishing aids may be used to assist in concrete finishing. Product is required to be worked into the surface immediately after applying.
   b. Type S-1, steel troweled finish:
      1) This finish type is only allowed on concrete with less than 3% air content.
      2) Finish by screeding and floating with straight edges to bring surfaces to the required finish elevation.
      3) While concrete is still green but sufficiently hardened to bear a person's weight without deep imprint, wood float to a true, even plane without visible coarse aggregate.
      4) Use sufficient pressure on wood floats to bring moisture to the surface.
      5) After surface moisture has disappeared, hand trowel concrete to produce a smooth, impervious surface, free from trowel marks.
      6) Burnish the surface with an additional troweling.
      7) Final troweling shall produce a ringing sound from the trowel.
      8) Do not use dry cement or additional water during troweling nor excessively trowel.
      9) Power finishing:
         a) An approved power machine may be used in lieu of hand finishing in accordance with the Machine Manufacturer's instructions.
         b) Do not use a power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
         c) Do the first steel troweling by hand.
   c. Type S-2, wood float finish:
      1) Finish slabs to receive fill and mortar setting beds by screeding with straight edges to bring the surface to the required finish plane.
      2) Wood float finish to compact and seal the surface.
      3) Remove laitance and leave the surface clean.
      4) Coordinate with other finish procedures.
   d. Type S-3, underside elevated slab finish: When forming is removed, grind off projections on the underside of the slab and patch defective areas.
   e. Type S-5, broomed finish:
      1) Finish as specified for Type S-1 floor finish except omit final troweling and finish surface by drawing a fine-haired broom lightly across the surface to the surface finish acceptable to the ENGINEER.
      2) Broom in the same direction and parallel to expansion joints.
      3) On inclined slabs, broom perpendicular to slope except for round slabs; broom surface in a radial direction.
   f. Type S-6, sidewalk finish:
      1) Slope walks down 1/4 in/ft away from structures, unless otherwise shown on the Drawings.
      2) Strike off surface by means of a strike board and float with wood or cork float to a true plane, then hand magnesium float before brooming.
      3) Broom surface perpendicular to the direction of traffic or as shown on the Drawings.

4) Lay out sidewalk surfaces in blocks with a grooving tool, as shown on the Drawings or as directed by the ENGINEER.

g. Type S-7, power float finish:
1) Finish by screeding and floating with straight edges to bring surfaces to the required finish elevation. Use sufficient pressure on floats to bring moisture to the surface.
2) During or after the first floating, check the planeness of the surface with a 10-foot straight edge applied at two or more different angles. Cut down high spots and fill low spots to achieve a true plane within 1/8 inch in 10 feet.
3) After floating, stop concrete finishing until bleeding ceases and concrete can support foot pressure with 1/8 inch indentation. While concrete is still green but sufficiently hardened, power float to a true, even plane without visible coarse aggregate.
4) Power float with an approved power machine in accordance with the Machine Manufacturer's instructions. Do not use a power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.

h. Concrete curbs:
1) Float top surface of curb smooth and finish discontinuous edges with steel edger.
2) After concrete has taken its initial set, remove the front form and give the exposed vertical surface an ordinary wall finish, Type W-1.

3. Beams and columns:
a. General: Repair defective areas. Products and means of repair require Submittal and review.
b. Type B-1: Match wall Type W-1.
c. Type B-2:
1) Grind beams to remove form marks.
2) Match wall Type W-2.
d. Type B-3:
1) Repair rock pockets.
2) Fill air voids.
3) Match wall Type W-3.
e. Type C-1: Match wall Type W-1.
f. Type C-2:
1) Grind column to remove form marks.
2) Match wall Type W-2.
g. Type C-3:
1) Fill air pockets.
2) Match wall Type W-3.

B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
Exterior Wall Surfaces		
Above grade/exposed (above a point 6 inches below finish grade)	W-12	W-B
Above grade/covered with brick veneer or other finish material	W-1	W-A
Backfilled/waterbearing (below a point 6 inches below finish grade)	W-2	W-A
Backfilled/not waterbearing (below a point 6 inches below final grade)	W-1	W-A
Interior Wall Surfaces		
Covered water-holding tanks and basins/not painted or coated	W-2	W-A
Water-holding tanks, channels, and basins/painted or coated	W-5	W-A
Buildings, pipe galleries, and other dry areas/not painted or coated	W-3	W-A
Buildings and other dry areas/painted or coated	W-5	W-A
Exterior Slabs		
Water-holding tanks and basins	S-5	S-A
Top of wall/water-holding tanks and basins	S-5	S-A
Top of elevated slabs	S-5	S-A
Slabs to receive grout topping	S-2	S-A
Stairs and landings	S-5	S-B
Sidewalks	S-6	S-B
Other exterior slabs	S-5	S-A
Clearwells: Top of roof slab	S-7	S-A

Area	Type of Finish	Required Form Tolerances
Interior Slabs		
Top of elevated slabs	S-1	S-A
Water-holding tanks and basins	S-5	S-A
Buildings and other dry areas	S-1	S-B
Slabs to receive mortar setting beds for tile	S-2	S-A
Slabs to receive resilient flooring or carpet	S-1	S-A
Hydraulic channels	S-1	S-A
Clearwells, top of footing, top of walls, all surfaces in contact with bearing pads, and waterstops	S-1	S-A
Clearwell floor slabs	S-7	S-A
Underside of elevated slabs	S-3	S-A
Beams and Columns		
Exposed beams	B-3	B-A
Concealed beams	B-2	B-A
Columns	C-3	C-A
Clearwell columns	C-2	C-A

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for concrete curing.
- B. Related Sections:
  1. SECTION 01 44 33 – MANUFACTURER'S SERVICES
  2. SECTION 03 15 05 – ANCHORING TO CONCRETE
  3. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 305.1 – Specification for Hot Weather Concreting
  2. 306.1 – Standard Specification for Cold Weather Concreting
  3. 308.1 – Specification for Curing Concrete
- B. ASTM International (ASTM):
  1. C 1315 – Standard Specification for Liquid Membrane–Forming Compounds Having Special Properties for Curing and Sealing Concrete
  2. D 2103 – Standard Specification for Polyethylene Film and Sheeting
- C. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. Evaporation retardant.
  2. Curing compound.
  3. Clear floor sealer/hardener.
  4. Finishing/trowel aid.
  5. Single use curing blanket.
  6. White burlap-PE sheet (burlene).
- B. Shop Drawings: Proposed curing methods.
- C. Quality Control Submittals:
  1. Curing compound: The Manufacturer's certificate of compliance showing moisture retention requirements.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Curing Compound:
  1. Euclid Chemical Co., Super Diamond Clear VOX
  2. WR Meadows, Inc., VOCOMP 30
  3. Vexcon Chemical, Inc., Starseal 1315
  4. Dayton Superior, Safe Cure and Seal 1315 EF
- B. Evaporation Retardant:
  1. BASF Building Systems, MasterKure ER 50
  2. Euclid Chemical Co., Eucobar
- C. Clear Floor Sealer/Hardener:
  1. BASF Building Systems, MasterKure HD 200WB
  2. Euclid Chemical Co., Eucosil
- D. Single Use Curing Blanket:
  1. Sika Corporation, Ultracure NCF

2.2 MATERIALS
- A. PE Film: Sheet type with minimum 6 mil thickness.
- B. White Burlap-PE Sheet (Burlene):
  1. Minimum weight: 10 oz/linear yard.
  2. Minimum width: 40 inches.
  3. PE:
     a. Securely bonded to burlap with no separation.
     b. Minimum thickness: 0.004 inch in accordance with ASTM D 2103.
- C. Curing Compound: Water-based, high solids content, non-yellowing curing compound in accordance with ASTM C 1315 Type I, Class A.
- D. Evaporation Retardant:
  1. Fluorescent color tint that disappears completely upon drying.
  2. Use only with the ENGINEER's written approval.
- E. Clear Floor Sealer/Hardener:
  1. Colorless, inorganic silicate-based compound manufactured specifically to harden, seal, and dustproof the concrete surfaces.
  2. Do not use sealer/hardener as a curing compound. Prior to application, water cure the concrete surfaces to receive sealer/hardener as specified.
- F. Finishing/Trowel Aid: As specified in SECTION 03 30 00.
- G. Water: Clean and potable, containing less than 50 ppm chlorides.

PART 3 EXECUTION

3.1 INSTALLATION

A. Finishing/Trowel Aid: Applied as specified in SECTION 03 30 00.

B. Evaporation Retarder/Reducer:

1. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures, unless the product is NSF/ANSI 61 certified.
2. Use evaporation retarder/reducer immediately after screeding and between finishing operations only if the evaporation rate is in excess of 0.2 lb/ft2/hr in accordance with ACI 305.1.
3. After applying the evaporation retarder/reducer, wait to start the next finishing operation until after the surface sheen of the evaporation retarder/reducer has disappeared.
4. The evaporation retarder/reducer shall not be finished into the surface by a finishing tool.
5. The evaporation retarder/reducer shall not be used as a finishing aid.

C. Clear Floor Sealer/Hardener:

1. Apply to floor surfaces where shown on the Drawings.
2. Before application:
   a. Keep concrete free from contaminants that may inhibit penetration of sealer/hardener. If contaminants are present, remove by means other than acids or chemicals.
   b. Water cure the slab for a minimum of 28 days.
   c. Allow the slab to dry completely and remove dust and debris.
   d. Ensure overhead Work is complete before applying sealer/hardener to prevent damage to the coating.
   e. Refer to the Manufacturer's instructions for any additional pre-application requirements.
3. Apply sealer/hardener evenly and in accordance with the Manufacturer's instructions using three coats.

D. Curing of Concrete:

1. General:
   a. Cure concrete in accordance with ACI 305.1, ACI 306.1, and ACI 308.1.
   b. Use only water curing on potable water structures.
2. Submit the curing method for approval for each of the following:
   a. Walls, beams, and columns:
      1) General: Where walls, beams or columns are to receive coatings, painting, cementitious material, or other similar finishes, or where solvent-based coatings are not permitted, use only water curing procedures.
      2) Method 1:
         a) Leave concrete forms in place.
         b) Keep entire surfaces of forms and concrete wet for 7 days.
      3) Method 2: Apply curing compound, where allowed, immediately after the removal of forms.
      4) Method 3: Continuously sprinkle with water 100% of the exposed surfaces for 7 days starting immediately after the removal of forms.
      5) Method 4:
         a) After the removal of concrete forms, completely saturate 100% of the concrete surface.
         b) Cover or wrap the entire exposed concrete surface in burlene.
         c) Monitor the concrete surface daily and ensure 100% of the surface remains wet for 7 days.
   b. Concrete slabs:
      1) Method 1:
         a) Leave concrete in forms.
         b) Flood or pond cure the exposed surface with water a maximum of 25ºF cooler than the concrete surface temperature.
         c) Maintain a minimum 2-inch water cover depth for a minimum 7 days.
      2) Method 2:
         a) Place soaker hoses in a serpentine pattern on top of the finished surface.
         b) Cover soaker hoses with burlene.
         c) Turn on soaker hoses until the entire slab is saturated.
         d) The maximum temperature differential between the surface of the slab and the water applied shall be 25ºF.
         e) Keep the slab completely saturated for the 7-day curing cycle.
         f) Pull burlene back at least four times per day to check that the surface is completely saturated for the first 7 days after placement, at a minimum.
         g) Leave edge forms in place where practical.
         h) If edge forms are removed, the edge shall be moist cured for 7 days.
         i) Provide sufficient means to hold blankets in place.
      3) Method 3:
         a) Leave concrete in forms.
         b) Use a single use wet cure blanket in accordance with the Manufacturer's instructions.
         c) Maintain for a minimum of 7 days.
      4) Method 4:
         a) Apply curing compound, where allowed, immediately after the removal of forms.
         b) When curing compound has set up, completely saturate 100% of the exposed concrete surfaces with water.
         c) Cover the entire exposed concrete surface in burlene or PE film.

d) Pull burlene or PE film back at least four times per day to check that the surface is completely saturated for the first 7 days after placement, at a minimum.

c. Sidewalks, curbs, gutters, pipe encasements, and ductbank:
   1) Begin concrete curing immediately after final finishing so as not to damage the surface.
   2) Method: Cover the surface with burlap or burlene and keep continuously wet for 7 days.
   3) Other approved methods that will keep moisture present and uniform on the exposed surfaces.
   4) Where water curing during cold weather is not possible or when jurisdictional requirements preclude other methods, use the approved curing compound at the Manufacturer's recommended coverage rate.
   5) Where curing compound cannot be used, obtain approval for special methods using moisture prior to placing the concrete.
   6) Protect sidewalks during cold weather with PE film or other material inside the required heated enclosure if foot traffic is permitted during curing.

3. Use only water curing where additional finishes such as sealer/hardener, painting, and other special coatings are required.
4. The curing system shall remain in place and be maintained for 7 days following placement.
5. No construction, dead, or live loads are to be applied to new concrete until concrete has attained 80% of the specified 28-day compressive strength as determined by field cylinders, or 7 days at a minimum.
6. Requirements for installing anchors in concrete less than 28 days after placement shall be as specified in SECTION 03 15 05.

3.2 QUALITY CONTROL

A. Manufacturer's Field Services:
1. At the ENGINEER's request, provide the Manufacturer's Representative at the site as specified in SECTION 01 44 33 for installation assistance, inspection, and certification of proper installation for the products specified.
2. Provide the Floor Sealer/Hardener Manufacturer's Representative to demonstrate the proper application of the product.
3. Provide the Curing Compound Manufacturer's Representative to demonstrate the proper application of curing compound to show coverage in one coat.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 45 00
PRECAST ABOVE-GRADE CONCRETE STRUCTURES

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for precast above-grade concrete structures.
- B. Related Sections:
  1. SECTION 01 44 33 – MANUFACTURER'S SERVICES
  2. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
  3. SECTION 07 92 00 – JOINT SEALANTS
  4. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 301 – Specification for Structural Concrete
  2. 318 – Building Code Requirements for Structural Concrete
- B. ASTM International (ASTM):
  1. C 33 – Standard Specification for Concrete Aggregates
  2. C 88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
  3. C 150 – Standard Specification for Portland Cement
  4. C 260 – Standard Specification for Air-Entraining Admixtures for Concrete
  5. C 494 – Standard Specification for Chemical Admixtures for Concrete
  6. C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  7. C 979 – Standard Specification for Pigments for Integrally Colored Concrete
  8. C 1012 – Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
  9. C 1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

1.3 SEQUENCING AND SCHEDULING
- A. Foundation Slab:
  1. Place foundation slab on a base of compacted structural fill over a prepared subgrade as shown on the Drawings.
  2. Cast foundation slab with embedded connection plates as required by the Building Manufacturer.
  3. Provide a level foundation slab.
- B. Access and Clearance:
  1. Verify the access road has sufficient turning radius for delivery and installation equipment.
  2. Provide a level unobstructed area large enough for the Manufacturer's delivery and installation equipment. Provide sufficient room for crane outriggers.

1.4 SUBMITTALS
- A. Shop Drawings:
  1. Show dimensions, joint locations, connection details.
  2. Show wall blockout locations and dimensions:
     a. Vents.
     b. Doors.
     c. Penetrations required for electrical and mechanical conduits, pipe, or equipment.
- B. Material Information:
  1. Concrete:
     a. The concrete mix design shall be stamped and sealed by a Professional Engineer registered in the State of Colorado.
     b. Compressive strength reports from field data.
     c. Product data for the mix constituents, including cement, supplementary cementitious materials, admixtures, and aggregates.
     d. Product data for materials and methods.
     e. Integral color selection chart, where necessary.
  2. Reinforcing steel.
  3. Embedded steel items.
  4. Steel connection plates and devices.
  5. Steel fasteners.
  6. Joint sealants.
  7. Vents.
- C. Engineered Calculations:
  1. Provide fastener/connection calculations.
  2. Prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
  3. Meet the design requirements of ACI 318.
- D. Manufacturer's installation recommendations.
- E. Manufacturer's certificate of proper installation, as specified in SECTION 01 44 33.

1.5 QUALITY ASSURANCE
- A. The building fabricator shall be a certified producer/member of the PCI or the NPCA.
- B. The Manufacturer shall have a minimum of 5 years of documented experience in the Work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. Building may be delivered pre-assembled or as individual panels for field assembly.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Concrete Building:

1. Dimensions:
   a. Outside building dimensions, plan and height as shown on the Drawings.
2. Wall, floor, and roof penetrations as shown on the Drawings.
3. Roof:
   a. Style and slope as shown on the Drawings.
   b. Overhang as shown on the Drawings, 1 foot horizontal distance minimum.
   c. Concrete color: Dark brown to complement the exposed aggregate of walls.
      1) Integral concrete coloring admixture to concrete:
         a) In accordance with ASTM C 494 and ASTM C 979.
         b) Single-component packaged in cubic yard dosage increments.
         c) The concrete mix design shall be coordinated with the requirements of the coloring admixtures and be compatible with the other admixtures.
         d) The color shall be selected by the ENGINEER from the Manufacturer's standard color range.
   d. Steel inserts for lifting the roof panels into place shall be capped with plastic plugs and sealed against weather for future use by the OWNER. Provide the OWNER with a full set of lifting bolts/lugs specific for use with the roof lifting inserts.
4. Foundation slab: Cast-in-place concrete thickness, reinforcement, and plan dimensions as shown on the Drawings.
   a. Concrete color to match the roof concrete color.
   b. Precast concrete alternative:
      1) The Manufacturer may submit an engineered precast foundation slab as an alternative to the cast-in-place concrete slab.
      2) Coordinate floor penetrations for mechanical and electrical requirements with the Drawings.
5. Concrete finish: Grade B in accordance with ACI 301.
6. Panel connections:
   a. Steel brackets, hot-dipped galvanized.
   b. Inserts for corner connections shall be secured to the form before casting.

B. Concrete Mix:

1. Mix design: Meet the requirement of CDOT Class D, as specified in SECTION 03 30 00, at a minimum. More stringent requirements may be required by the ENGINEER for specific structure in accordance with the Contract Documents.
2. Cementitious materials: Type II portland cement in accordance with ASTM C 150.
3. Fly ash:
   a. Class C or Class F fly ash in accordance with ASTM C 618, except that loss on ignition shall not exceed 4%. Class C shall also be qualified for moderate sulfate resistance as described in ASTM C 618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C 1012.
   b. Make fly ash additions to the mix on a cement substitution basis in accordance with ASTM C 618.
4. Aggregates:
   a. Furnish from one source.
   b. Natural aggregates:
      1) Free from deleterious coatings and substances in accordance with ASTM C 33, except as modified herein.
      2) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on the surface of concrete.
   c. Alkali reactivity of aggregates:
      1) In accordance with ASTM C 33.
      2) Tested for reactivity in accordance with ASTM C 1260.
      3) A maximum of 0.10% expansion at 16-day soak for any aggregate product used in portland cement concrete.
   d. Aggregate soundness:
      1) Test fine and coarse aggregates in accordance with ASTM C 33, and ASTM C 88 using a sodium sulfate solution.
   e. Grading and quality requirements in accordance with ASTM C 33.
   f. Fine aggregate:
      1) Admixtures:
         a) Furnish from one Manufacturer.
         b) Free of chlorides or other corrosive chemicals.
         c) In accordance with ASTM C 494 and ASTM C 260.
         d) Meeting the requirements of SECTION 03 30 00.
5. Water: In accordance with ASTM C 1602.

2.2 ACCESSORIES

A. Joint Sealants: As specified in SECTION 07 92 00. Sealant color shall complement concrete and exposed aggregate colors.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's recommendations.
B. Seal joints with an application-appropriate sealant as specified in SECTION 07 92 00.
C. Repair damaged galvanized steel surfaces as specified in SECTION 09 90 00, System No. 11.
D. Coat non-galvanized interior and exterior steel plates and connection members as specified in SECTION 09 90 00, System No. 6.

3.2 QUALITY CONTROL

A. Construction tolerances of precast members shall be within the Manufacturer's recommended range of values for wall plumbness, roof slope, and panel closures.

END OF SECTION

INTENTIONALLY BLANK

SECTION 03 60 00
GROUT FLOOR TOPPING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for grout floor topping.
- B. Related Sections:
  1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
  2. SECTION 03 39 00 – CONCRETE CURING

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 33 – Standard Specification for Concrete Aggregates
  2. C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  3. C 150 – Standard Specification for Portland Cement

1.3 SUBMITTALS
- A. Cement Grout Alternative:
  1. Manufacturer’s product data.
  2. Manufacturer instructions:
     a. w/cm ratio for use in this Work.
     b. Mixing instructions.
     c. Installation instructions.
  3. Quality control Submittals:
     a. Manufacturer statement that the CONTRACTOR is an approved applicator for products used for this Work.
     b. Manufacturer's certificate of compliance: Grout free from chlorides and other corrosion-causing chemicals.
  4. Warranty documentation:
     a. Sample warranty.
     b. Warranty.
- B. Concrete Grout Alternative: Include Submittal information required for concrete as specified in SECTION 03 30 00.
- C. Contractor Methodology:
  1. Sequencing method.
  2. Proposed method for keeping concrete surfaces wet prior to placing grout.
  3. Method of curing as specified in SECTION 03 39 00.

1.4 QUALITY ASSURANCE
- A. Grout Manufacturer's Representative Qualifications:
  1. A minimum of 1 year of documented experience in the Work of this Section.
  2. An authorized and trained representative of the Grout Manufacturer.
- B. Field Testing: OWNER’s QA field testing and inspection services shall be provided by the ENGINEER. Assist in the sampling of materials and provide any ladders, platforms, etc., for access to the Work. The methods of testing shall be in accordance with ASTM C 39.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the Manufacturer's name, product identification, batch numbers, and printed instructions.
- B. Store materials in accordance with the Manufacturer's recommendations. Total storage time from the date of manufacture to the date of installation shall be limited to 6 months or the Manufacturer's recommended storage time, whichever is less.
- C. Material that becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the OWNER.
- D. Cement grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.

1.6 WARRANTY
- A. Contractor’s warranty, as stipulated in the General Conditions shall cover materials and installation for the entire warranty period.
- B. Any dispute between the CONTRACTOR and the Manufacturer about the cause of the warranty issue shall not be cause for delay in making necessary repairs when identified.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Cement Grout:
  1. Sika Corporation, SikaCrete 211

2.2 MATERIALS
- A. Cement Grout: Cement grout shall be a one-component mixture containing portland cement in accordance with ASTM C 150, Type II, aggregates in accordance with ASTM C 33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.
- B. Concrete Grout: As specified SECTION 03 30 00 except as specified herein. Proportion with Type II cement, fine aggregates, water, water reducing admixture and air entraining agent to produce a mix having an average strength of 4,500 psi at 28 days. Aggregate size shall be 3/8 inch maximum. Minimum cement content shall be 600 lbs/cy and maximum water to cement ratio shall be 0.42.
- C. Water: Potable water.

PART 3 EXECUTION

3.1 PREPARATION

A. Grout shall be placed over cured concrete that has attained its full design strength unless otherwise approved by the ENGINEER.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance, and paints, and free of loose material or foreign matter that may affect the bond or performance of the grout.

C. Remove loose rust, oil, or other deleterious substances from metal embedments or the bottom of baseplates prior to the installation of the grout.

D. Prepare concrete substrate by using a high-pressure water blast (30,000 psi to 40,000 psi) to obtain a minimum surface profile of 1/8 inch. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance, and firmly embedded into the parent concrete.

E. Concrete surfaces shall be washed clean and kept moist for at least 1 day prior to the placement of grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the ENGINEER. Upon completion of the 1-day period, visible water shall be removed from the surface prior to grouting.

F. Construct grout forms or other leak-proof containment as required. Forms shall be lined or coated with release agents recommended by the Grout Manufacturer. Forms shall be of adequate strength, securely anchored in place, and shored to resist the forces imposed by the grout and its placement.

3.2 INSTALLATION

A. General:

1. Substrate shall be saturated surface dry with no standing water during application.
2. Maintain sufficient manpower and equipment for rapid and continuous placement. Keep necessary tools and materials ready and close at hand.
3. Place topping to a minimum installation thickness of 1 inch, or unless otherwise approved in writing by the ENGINEER.
4. Place grout rapidly and continuously to avoid cold joints. Do not place grout in layers. Do not add additional water to the mix or retemper after initial stiffening.
5. Place concrete grout to the final grade using appropriate means and methods to eliminate high and low spots.
6. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement shall proceed in a manner that ensures the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
7. Maintain temperatures of the supporting concrete, and grout between 40°F to 90°F during grouting and until grout compressive strength reaches 1,000 psi or as recommended by the Grout Manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of grout during the curing period.
8. Take precautions for hot weather or cold weather grouting as recommended by the Manufacturer when ambient temperatures or the temperature of the materials in contact with the grout are outside of the 60°F to 90°F range.
9. Install grout in a manner that preserves the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint. Reflect existing underlying expansion, control, and construction joints through the grout.

B. Cement Grouts:

1. Mix in accordance with the Manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without the prior approval of the ENGINEER.
2. Do not mix by hand. Mix in a mortar mixer with moving blades. Pre-wet the mixer and empty excess water. Add a pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the Manufacturer and add the minimum additional water required to obtain workability.
3. Do not exceed the Manufacturer's maximum recommended water content.

C. Curing:

1. Begin curing immediately after form removal and finishing.
2. Cure the concrete grout as specified in SECTION 03 30 00.
3. Keep grout topping moist and within its recommended placement temperature range for at least 1 day after placement or longer if recommended by the Manufacturer. Saturate the grout surface by the use of wet burlap, soaker hoses, ponding, or other approved means as specified in SECTION 03 39 00. Provide sunshades as necessary.
4. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

END OF SECTION

SECTION 03 62 00
NON-SHRINK GROUTING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for non-shrink grouting.
- B. Related Sections:
  1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
  2. C 1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Product data of grouts.
  2. Installation instructions for grout.
  3. Sequencing schedule and curing methods for grout topping.
  4. Proposed method for keeping concrete surfaces wet prior to placing grout.
  5. Curing method for grout.
- B. Quality Control Submittals:
  1. Manufacturer's instructions:
     a. Adding fiber reinforcing to batching.
     b. w/cm ratio of grout topping, specifically for intended use in this Work.
     c. Mixing of grout.
  2. A letter from the Manufacturer that the CONTRACTOR is an approved applicator for products used for this Work.
  3. Manufacturer's certificate of compliance:
     a. Grout free from chlorides and other corrosion-causing chemicals.
     b. Non-shrink grout properties of Categories II and III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion, and non-shrink properties are not based on gas or gypsum expansion.
  4. Manufacturer's certificate of proper installation.
  5. Statements of qualification: Non-Shrink Grout Manufacturer's Representative.
  6. Test reports:
     a. Test report for the 1 day evaluation of non-shrink grout; an independent testing laboratory shall certify that the testing was conducted within the past 18 months; a test report for a 1 day evaluation is required only if the non-shrink grout used differs from the Manufacturer’s end products listed in this Section.
     b. Test results and a service report from the demonstration and training session.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.
- D. Supplements listed in this Section.

1.4 QUALITY ASSURANCE
- A. Qualifications:
  1. Non-Shrink Grout Manufacturer's Representative:
     a. A minimum of 1 year of documented experience in the Work of this Section.
     b. An authorized and trained Representative of the Grout Manufacturer.

1.5 WARRANTY
- A. Manufacturer:
  1. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the non-shrink grouting system and associated appurtenances.
  2. The Manufacturer's warranty shall not contain a disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and the materials furnished.
  3. The Manufacturer warranties participation with the CONTRACTOR in replacing or repairing grout found to be defective due to faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Non-Shrink Grout:
  1. Category I:
     a. Dayton Superior Corp., Sure-Grip High Performance Grout
     b. Euclid Chemical Co., NS Grout
     c. Sika Corporation, SikaGrout 212
  2. Category II:
     a. BASF Building Systems (Master Builders), MasterFlow 928
     b. Euclid Chemical Co., Hi Flow Grout
     c. Five Star Products Inc., Fluid Grout 100
     d. Sika Corporation, SIkaGrout 328

3. Category III:
    a. Escoweld Industrial Grouts and Polymers, Escoweld 7505E/7530
    b. Sika Corporation, Sikadur 42, Grout Pak

2.2 MATERIALS

A. Non-Shrink Grout:
    1. Category I:
        a. Nonmetallic and nongas-liberating flowable fluid.
        b. Prepackaged natural aggregate grout requiring only the addition of water.
        c. Test in accordance with ASTM C 1107:
            1) Flowable consistency 140%, five drops in 30 seconds.
            2) Flowable for 15 minutes.
        d. Grout shall not bleed at the maximum allowed water.
        e. Minimum compressive strength of grout: 3,000 psi at 3 days; 5,000 psi at 7 days; 7,000 psi at 28 days.
    2. Category II:
        a. Nonmetallic, nongas-liberating flowable fluid.
        b. Prepackaged natural aggregate grout requiring only the addition of water.
        c. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
        d. Test in accordance with ASTM C 1107:
            1) Fluid consistency 20 to 30 seconds.
            2) Temperatures of 40ºF, 80ºF, and 100ºF.
        e. One hour after mixing, pass fluid grout through a flow cone with continuous flow.
        f. Minimum compressive strength of grout: 2,500 psi at 1 day; 4,500 psi at 3 days; and 7,000 psi at 28 days.
    3. Category III:
        a. Pre-proportioned, epoxy, baseplate grouting system.
        b. Three-component Grout Pak, 100% solids, moisture-tolerant.
        c. Non-shrink, self-leveling, flowable.
        d. Minimum compressive strength of grout: 14,000 psi at 28 days in accordance with ASTM C 579.

B. Grout for Horizontal Construction Joints in Walls: Flowable, consisting of sand, water, and a minimum of 12 sacks of cement per cubic yard.

PART 3 EXECUTION

3.1 INSTALLATION

A. Non-Shrink Grout:
    1. General:
        a. Mix grout proportions in accordance with the Manufacturer’s instructions for specific intended use in order to meet w/cm ratio and consistency requirements.
        b. Mix, place, and cure non-shrink grout in accordance with the Grout Manufacturer's instructions.
    2. Form tie or through-bolt holes: Patch as specified in SECTION 03 30 00.
    3. Grouting machinery foundations:
        a. Block out original concrete or finish off the distance shown on the Drawings below the bottom of the machinery base plate for grout.
        b. Prepare the concrete surface by sand blasting, chipping, or by mechanical means to remove any soft material.
        c. Set the machinery in position and adjust to the proper elevation with cast-in jacking bolts.
        d. Form with watertight forms at least 2 inches higher than the bottom of the matching base plate.
        e. Fill the space between the bottom of the machinery base plate and the existing concrete in accordance with the Manufacturer's instructions.
        f. Completely fill the space beneath the equipment. Drilling holes in pre-manufactured bases may be required.

B. Horizontal Construction Joints in Reinforced Concrete Walls:
    1. Use a positive measuring device, such as a bucket or other device that will contain only enough sand-cement grout, for depositing in one place in the wall to ensure that portion of the form does not receive too much grout.
    2. Limit grout placement to a 2 inch maximum thickness.
    3. Do not deposit grout from pump hoses or large concrete buckets unless inspection windows near the joint are available to allow for a visual measurement of the grout thickness and a means for excess grout overflow is available.

3.2 QUALITY CONTROL

A. Manufacturer's Services:
    1. General:
        a. Coordinate demonstrations, training sessions, and applicable site visits with the Grout Manufacturer's Representative.
        b. Provide and conduct on-site demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of non-shrink grout.
        c. Coordinate to ensure that necessary equipment and materials are available for demonstration.
    2. Training:
        a. The Grout Manufacturer's Representative shall train the CONTRACTOR in proper installation methods for grout.
        b. Establish a location at the Work site and schedule a time for the Grout Manufacturer's demonstration and training session of proposed non-shrink grouts.

c. Mix non-shrink grouts to the required consistency; test, place, and cure on the actual Work including baseplates and tie holes to simulate actual on-the-job training.
d. Use a minimum of five bags for each grout Category II and Category III.

3.3 NON-SHRINK GROUT SCHEDULE

A. Furnish non-shrink grout for applications in grout category in the following schedule:

	Temperature Range	**Maximum Placing Time**	
Application	**40°F to 100°F**	**20 minutes**	**Greater than 20 minutes**
Filling tie holes	I or II	I or II	I or II
Machine bases 25 hp or less	II	II	II
Through-bolt openings	II	II	II
Patching concrete walls	II	II	II
Machine bases 26 hp and up	III	III	III

3.4 SUPPLEMENTS

A. Supplement A – 1-Day Evaluation of Non-Shrink Grout Test Form

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A
1-DAY EVALUATION OF NON-SHRINK GROUT TEST FORM

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

OBJECTIVE: Define a standard set of test procedures for an independent testing laboratory to perform and complete within a 1-day period.

SCOPE: Utilize test procedures providing 1 day results to duplicate field grouting demands. The intent of evaluation is to establish the Grout Manufacturer's qualifications.

PRIOR TO TEST: Obtain five bags of each type of grout from the intended Grout Supplier for the Work. The five bags of grout shall be of the same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR THE GROUT BEING TESTED FROM THE LITERATURE AND DATA ON THE BAG:*

A. Is product data and warranty information contained in company literature and data?

YES_____ NO_____

B. Do the literature and bag information meet specified requirements?

YES_____ NO_____

C. Does the Manufacturer guarantee grout as specified in SECTION 03 62 00?

YES_____ NO_____

D. Does the guarantee extend beyond the grout replacement value and allow participation with the CONTRACTOR in replacing and repairing defective areas?

YES_____ NO_____

E. Are water demands and limits printed on the bag?

YES_____ NO_____

F. Is mixing information printed on the bag?

YES_____ NO_____

G. Are temperature restrictions printed on the bag?

YES_____ NO_____

*Grout will be rejected if one or more answers are noted as NO.

INTENTIONALLY BLANK

SECTION 03 63 00
EPOXY GROUTING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for epoxy grouting.

1.2 DEFINITIONS
- A. Large Cracks: Width greater than 0.015 inch.
- B. Small Cracks: Width less than or equal to 0.015 inch.

1.3 SUBMITTALS
- A. Product Data.
- B. Shop Drawings:
  1. Installation of grout.
  2. Sequencing schedule and curing methods for grout.
- C. Quality Control Submittals:
  1. Epoxy grout:
     a. Manufacturer's instructions for the mixing of grout.
     b. A letter from the Manufacturer that the CONTRACTOR is an approved applicator of products used for the Work.
     c. Manufacturer's certificate of compliance that grout is free from chlorides and other corrosion-causing chemicals.
     d. Manufacturer's certificate of proper installation.
     e. Statements of qualification: Epoxy Grout Manufacturer's Representative.
     f. Test reports:
        1) Test report for a 1-day evaluation of epoxy grout; an independent testing laboratory shall certify that testing was conducted within the past 18 months.
        2) Test results and a service report from the demonstration and training session and from field tests.
        3) Field test reports and laboratory test results for field-drawn samples.
  2. Epoxy surface adhesive cap:
     a. Physical and chemical properties.
     b. Surface preparation procedures and application instructions in accordance with the Manufacturer’s instructions.
     c. Material limitations.
     d. Daily records as specified in this Section.
  3. Epoxy injections: Provide written daily reports describing, at a minimum, where the injections took place, the pressure at installation, the area covered during the workday, the ambient air temperature, and any unusual conditions encountered.
- D. Contract Closeout Submittals:
  1. Epoxy injection adhesive: Two-component ratio and injection pressure test records for concrete crack repair Work.

1.4 QUALITY ASSURANCE
- A. Epoxy Injection Adhesive Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Packing and Shipping: Pack epoxy injection adhesive material in new, sealed containers and label with the following information:
  1. The Manufacturer’s name.
  2. Product name and lot number.
  3. ANSI hazard classification (formerly SPI classification).
  4. ANSI recommended precautions for handling.
  5. The mix ratio by volume.
  6. Date of manufacture and shelf life.
- B. Storage and Protection:
  1. Store adhesive containers at ambient temperatures within parameters recommended by the Manufacturer.
  2. Store epoxy to be used for crack injection at a minimum 70°F.
  3. Product shall not exceed the Manufacturer’s instructions for shelf life.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Epoxy Injection and Gravity Feed Grout:
  1. Sika Corporation, Sikadur 35 Hi-Mod LV
- B. Epoxy Surface Sealer for Concrete Slabs:
  1. Sika Corporation, Sikadur 55 SLV
- C. Epoxy Surface Adhesive Cap for Concrete Walls:
  1. Sika Corporation, SIkadur 33

2.2 MATERIALS
- A. Epoxy Injection and Gravity Feed Grout:
  1. Very low viscosity, two-component moisture-tolerant structural epoxy injection adhesive.
  2. Suitable for use with potable water.

3. Component A properties: A blend of modified epoxy resins.
4. Component B properties: A modified amine curing agent.

2.3 ACCESSORIES

A. Surface Seal:

1. Of sufficient strength and adhesion to hold injection fittings firmly in place, resist pressures, and prevent leakage during injection.
2. Capable of being removed after epoxy injection adhesive has cured.

PART 3 EXECUTION

3.1 INSTALLATION

A. Epoxy Injection Adhesive:

1. Mix and install in accordance with the Manufacturer's instructions.
2. Preparation:
   a. Clean surfaces with 3,000 psi water blast.
   b. Surfaces to receive epoxy and adjacent surfaces shall be free of contaminants.
   c. Clean surfaces in accordance with the Epoxy Injection Adhesive Manufacturer's instructions.
   d. Do not use acids and corrosives for cleaning unless neutralized prior to injecting epoxy.
3. Application – crack injection:
   a. Crack injection equipment:
      1) Portable, positive displacement type pumps with inline metering to meter and mix two adhesive components and inject mixture into the crack.
      2) Pumps:
         a) Electric or air-powered with interlocks providing the positive ratio control of proportions for two components at the nozzle.
         b) A primary injection pump for each material of different mix ratio including a standby backup pump of similar ratio.
         c) Capable of immediate compensation for changes in resins.
         d) Do not use batch mix pumps.
      3) Discharge pressure: Automatic pressure controls capable of discharging and maintaining a mixed adhesive at pressures up to 200 psi, ±5%.
      4) Automatic shutoff control: Provide sensors on both Component A and Component B reservoirs for stopping the machine automatically when only one component is being pumped to the mixing head.
      5) Proportioning ratio tolerance: Maintain the Epoxy Adhesive Manufacturer's prescribed mix ratio within a tolerance of ±5% by volume at a discharge pressure up to 160 psi.
      6) Ratio/pressure check device:
         a) Two independently valved nozzles capable of controlling the flow rate and pressure by opening or closing a valve to restrict material flow.
         b) A pressure gauge capable of sensing pressure behind each valve.
   b. Sealing:
      1) Apply surface seal to the crack face prior to injection in accordance with the Manufacturer's instructions.
      2) Seal the surface of the crack to prevent the escape of injection epoxy.
   c. Entry ports:
      1) Establish openings for epoxy entry in the surface seal along the crack.
      2) Ensure the space between entry ports is equal to the thickness of the concrete member to allow epoxy to penetrate to the full thickness of the wall or slab.
      3) Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
      4) Space the entry points closer together to allow for the adjustment of injection pressure to attain a minimum loss of epoxy to the soil at a location where:
         a) Cracks extend entirely through the wall.
         b) There is a backfill of walls on one side.
         c) It is difficult to excavate behind the wall to seal both crack surfaces.
   d. Epoxy injection:
      1) Start the injection into each crack at the lowest elevation entry point.
      2) Continue the injection at the first port until adhesive begins to flow out of port at the next highest elevation.
      3) Plug the first port and start the injection at the second port until adhesive flows from the next port.
      4) Inject the entire crack following the same sequence.
   e. Finishing:
      1) Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without the draining or runback of epoxy material from the cracks.
      2) Remove surface seal from cured injection adhesive.
      3) Finish the crack face flush with adjacent concrete.
      4) Indentations or protrusions caused by the placement of entry ports are not acceptable.
      5) Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

4. Application – steel plates injection:
    a. Equipment – steel plate injection:
        1) Provide injection equipment in accordance with the Manufacturer's instructions.
        2) Discharge pressure:
            a) Provide automatic pressure controls that are capable of discharging a mixed epoxy injection adhesive at pressures up to 15 psi, ± 5%, and that are able to maintain pressure.
            b) Provide a calibrated pressure gauge to measure application pressures.
    b. General:
        1) Drawings show the standard pattern for injection ports on steel plates. Verify the frequency of injection ports meets the Epoxy Manufacturer's instructions. Provide additional injection ports as required.
        2) Install epoxy injection adhesive material after completing the welding of steel plate seams and after anchors have been installed and plug welded.
    c. Epoxy injection:
        1) Provide automated injection equipment for the installation of epoxy.
        2) Provide a means to prevent concrete dusts and fines from contaminating the injection ports due to the drilling of holes in the concrete for thread anchors.
        3) Do not exceed a 15 psi injection pressure while pumping epoxy injection adhesive under the steel plates.
        4) Allow the material to fill to adjacent injection ports provided on the steel plates prior to moving to a new injection port. Plug the first port prior to moving to adjacent ports.
        5) Fill at a rate specified by the Manufacturer.
        6) Allow air to escape through adjacent injection ports and in accordance with the Manufacturer's instructions.
        7) Before and during installation, store epoxy injection adhesive at the temperature indicated in the Manufacturer's instructions.
        8) Start the injection into each injection port at the lowest elevation entry port.
    d. Finishing:
        1) Allow the epoxy injection adhesive to cure prior to plug-welding ports and in accordance with the Manufacturer's instructions.
        2) Plug weld and grind smooth ports after epoxy injection adhesive is installed and cured.
        3) Hit surfaces with a ball peen hammer in the presence of the ENGINEER to ensure the full bearing of plates by sound. Re-inject in areas that, in opinion of the ENGINEER, sound hollow and are therefore considered not fully injected.
        4) Clean up and properly dispose of over spill epoxy injection adhesive material. Remove and properly dispose of epoxy injection adhesive material that is not under steel plates.

B. Epoxy Gravity Feeding of Cracks:
1. Mix and apply in accordance with the Manufacturer's instructions.
2. Surface preparation:
    a. Surfaces to be repaired or sealed shall be clean and sound.
    b. Remove bond-inhibiting contaminants from the concrete by mechanical means (sandblasting or shot blasting).
    c. Substrate shall be dry: Allow surfaces prepared by pressure washing to dry for at least 1 day.
    d. Apply material when the ambient and surface temperature is greater than or equal to 50°F and rising.
    e. As shown on the Drawings or as directed by the ENGINEER, rout individual cracks with an angle grinder to a vee-notch of 1/2 inch width and depth.
    f. Use low-height sand or wood dams to confine grout, establish a neat width of repair, and make positive head to assist the grout in penetrating the crack.
3. Mixing:
    a. Mix material on low-speed with a drill and paddle for approximately 3 minutes to ensure a thorough mix.
    b. Use mixed material in 20 minutes or less.
4. Placing:
    a. Place material incrementally using gravity to fill the crack.
    b. As material penetrates the crack, add additional material until it will no longer enter the crack (refusal); several iterations may be required to fill the crack to refusal.

C. Epoxy Gravity Surface Sealing:
1. Mix and apply in accordance with the Manufacturer's instructions.
2. Surface preparation:
    a. Surfaces to be repaired or sealed shall be clean and sound.
    b. Remove bond-inhibiting contaminants from the concrete by mechanical means (sandblasting or shot blasting).
    c. Substrate shall be dry: Allow surfaces prepared by pressure washing to dry for at least 1 day.
    d. Apply material when the ambient and surface temperature is greater than or equal to 50°F and rising.
    e. As shown on the Drawings or as directed by the ENGINEER, rout individual cracks with an angle grinder to a vee-notch of 1/2 inch width and depth.
    f. Use low-height sand or wood dams to confine grout, establish a neat width of repair, and make positive head to assist the grout in penetrating the crack.
3. Mixing:
    a. Mix material on low-speed with a drill and paddle for approximately 4 minutes to ensure a thorough mix.
    b. Use mixed material in 60 minutes or less.

4. Placing:
    a. Place material to horizontal surface by flat squeegee or broom.
    b. Spread material over cracks and to penetrate into cracks and substrate.
    c. Remove excess epoxy with a roller leaving no visible surface film.
    d. As required, repeat the application of epoxy for very porous surfaces.
    e. After final treatment with epoxy, wait 30 minutes and broadcast oven-dried sand over the surface at a rate of 30 lbs/sf Allow it to cure for 6 hours and remove any loose sand.

3.2 QUALITY CONTROL

A. Epoxy Injections:
    1. Provide written daily reports describing, at a minimum, where the injections took place, the pressure at installation, the area covered during the workday, the ambient air temperature, and unusual conditions encountered.
    2. Check equipment and gauges daily and repair or replace as required.

B. Epoxy Adhesive Two-Component Ratio Tests:
    1. Disconnect the mixing head and pump two adhesive components simultaneously through the ratio check device.
    2. Adjust discharge pressure to 160 psi for both adhesive components.
    3. Simultaneously discharge both adhesives into separate calibrated containers.
    4. Compare the amounts simultaneously discharged into the calibrated containers during the same time period to determine the mix ratio.
    5. Complete the test at 160 psi discharge pressure and repeat the procedure for 0 psi discharge pressure.
    6. Run a ratio test for each injection unit at the beginning and end of each injection workday, and when injection Work stops for more than 1 hour.
    7. Document and maintain complete and accurate records of ratios and pressure checks.

C. Injection Pressure Test:
    1. Disconnect the mixing head of the injection equipment and connect two adhesive component delivery lines to the pressure check device.
    2. Pressure check device:
        a. Two independently valved nozzles capable of controlling the flow rate and pressure by opening or closing a valve to restrict material flow.
        b. A pressure gauge capable of sensing pressure buildup behind each valve.
    3. Close valves on the pressure check device and operate the equipment until the gauge pressure on each line reads 160 psi.
    4. Stop pumps and observe pressure; do not allow the pressure gauge to drop below 150 psi within 3 minutes.
    5. Run a pressure test for each injection equipment unit:
        a. At the beginning and end of each injection workday.
        b. When injection Work stops for more than 45 minutes.
    6. Check tolerance to verify the equipment is capable of meeting the specified ratio tolerance.

D. Crack Injection Tests: As required by the ENGINEER.

END OF SECTION

SECTION 03 65 00
CHEMICAL GROUTING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for chemical grouting.
- B. Related Sections:
  1. SECTION 03 63 00 – EPOXY GROUTING
  2. SECTION 03 93 00 – CONCRETE REHABILITATION – REPAIR CONCRETE AND MORTAR

1.2 REFERENCES
- A. American Concrete Institute (ACI):
  1. 301 – Specifications for Structural Concrete
- B. ASTM International (ASTM):
  1. C 94 – Standard Specification for Ready-Mixed Concrete
  2. C 920 – Standard Specification for Elastomeric Joint Sealants
  3. D 412 – Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers – Tension
  4. D 624 – Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
  5. D 2240 – Standard Test Method for Rubber Property – Durometer Hardness
  6. D 5249 – Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
- C. Federal Specifications (FS):
  1. TT-S-001543A – Sealing Compound: Silicone Rubber Base
  2. TT-S-00230C – Sealing Compound: Elastomeric Type, Single Component

1.3 SUBMITTALS
- A. Product Data:
  1. Provide Manufacturer's specifications, data sheets, recommendations, installation instructions, guarantees, test reports, and other pertinent data on materials showing compliance with the contract requirements.
  2. Provide a list of items that have a limited shelf life or require special handling with a description of the limitations and requirements.
- B. Samples:
  1. Upon request, submit representative samples of proposed products in a sufficient quantity for independent examination and testing.
  2. When requested, the proposed samples shall be tested and certified by an independent testing laboratory at no expense to the OWNER.
- C. Quality Control Submittals:
  1. Prior to beginning repair Work, submit a detailed work plan; identify the following:
     a. Locations of repairs.
     b. Proposed methods of surface preparations.
     c. Installation methods.
     d. Products to be used.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
  3. Completed a program of instruction in the use of the specified repair material.
  4. Provide a notarized certification from the Manufacturer attesting to approved CONTRACTOR status or, if approved by the ENGINEER, provide five job references of successfully repaired concrete cracks with the specified product.
- B. Provide a notarized certificate stating the repair material meets the specified requirements and have the Manufacturer’s current literature on the specified product.
- C. System Description:
  1. Design requirements:
     a. Repair any crack whose width is greater than or equal to 0.010 inch at any point along the crack length.
     b. The repair of cracks using pressure injection or gravity grouting may be terminated when the crack width is less than or equal to 0.005 inch, or where applicable visible leakage ceases.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Comply with the Manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.
- B. Deliver materials in the Manufacturer's original, unopened, undamaged containers with the identification labels intact.
- C. Materials shall be stored and handled to ensure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection.
- D. Equipment that is used for the handling and transporting of materials shall be clean and in proper operating condition before any material is placed therein.

1.6 SITE CONDITIONS
- A. Ensure that substrate surface and ambient air temperature are a minimum of 45˚F and rising at the time of application and remain above 45˚F for at least 1 day after application. Ensure that frost or frozen surfaces are thawed and dry.
- B. Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain the temperature and conditions specified before proceeding with the application.

C. Schedule Work appropriately, or supply supplemental heat sources that will increase the Work environment to an acceptable temperature.
D. Do not apply over sealant joints, control joints, or other materials that will be affected by solvent.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Polyurethane Chemical Grout for Pressure Grouting:
1. DeNeef Construction Chemicals, Inc, Flex SLV PURE
2. Sealboss, Corp., Sealboss 1510 WaterStopFoam or 1570 LV WaterStopFoam

2.2 MATERIALS

A. General:
1. Use only approved materials in accordance with the Contract Documents.
2. Materials are subject to inspection and tests at any time during the process of preparation or use.
3. Obtain an approval for the source of supply of each material before delivery or use.

B. Polyurethane Chemical Grout for Pressure Grouting:
1. Non-flammable, high flash point, 212°F, hydrophobic polymer of type which is applied in the crack or open joint by use of packer; non-toxic.
2. When the grout is mixed with approximately 5% water, the material will expand to twenty times its original volume and cure to a golden-yellow, closed-cell polyurethane foam.
3. Properties of mixed polyurethane chemical grout:
a. Pot life: Approximately 5 hours providing no moisture enters the system.
b. Mixed viscosity: 300 cps.
c. Color: Light amber.
4. Accelerator:
a. Based on stannous octoate.
b. Able to control reaction time from 3 seconds to 30 seconds.
c. Catalyzed polyurethane chemical grout shall not react until it contacts water.

C. Water:
1. Potable.
2. In accordance with ASTM C 94.
3. Free from sewage, oil, acids, strong alkalis, vegetable matter, clay, loam, or other deleterious substance that might affect the performance of the grout.

2.3 ACCESSORIES

A. Closed-Cell Backer Rod: In accordance with ASTM D 5249.
B. Bond Breaker Tape: Adhesive-backed butyl or PE tape specifically manufactured to adhere to concrete or premolded joint filler.
C. Polyurethane Sealant:
1. One-component, gun-grade, low-modulus, polyurethane-base material.
2. Applicable in vertical and overhead joints.
3. Cure under the influence of atmospheric moisture to form an elastomeric substance.
4. Properties of uncured polyurethane sealant shall be as follows:
a. Initial cure, tack-free time: 4 to 8 hours.
b. Consistency: Non-sag.
c. Color: Limestone gray.
5. Properties of the cured polyurethane sealant shall be as follows:
a. Tensile properties, in accordance with ASTM D 412:
1) Tensile strength: 125 psi minimum at 21 days.
2) Elongation at break: 700% minimum.
3) Tensile stress at 100% elongation: 50 psi minimum.
4) Tensile set after break: 20% maximum.
b. Hardness, in accordance with ASTM D 2240: 25 maximum at 21 days (Shore A).
c. Tear strength, in accordance with ASTM D 624: 25 lb/in minimum at 21 days.
d. Adhesion in peel from concrete, in accordance with FS TT-S-00230C: 20 lb minimum at 28 days.
e. Service range: -40°F to 170°F.
f. In accordance with FS TT-S-00230C, Type II, Class A.
g. In accordance with ASTM C 920, Type S, Grade NS, Class 25.
h. Capable of +100% to -50% of the average joint width when tested in accordance FS TT-S-00230C, durability bond test.
i. Physical test requirements in accordance with FS TT-S-001543A.
j. Nonstaining.
k. Final cure: 7 to 10 days.

PART 3 EXECUTION

3.1 GENERAL

A. Furnish labor, materials, and services necessary for, and incidental to, the completion of Work as shown on the Drawings and specified herein.
B. Use equipment of sufficient size to meet the requirements of Work and to produce satisfactory Work.
C. Work is subject to the inspection and approval of the ENGINEER.

D. Employ a sufficient force of workmen of such experience and ability that Work can be completed in a satisfactory and workmanlike manner.
E. Provide notice to the ENGINEER 1 day prior to performing repair Work to permit the ENGINEER to review the surface preparation and Work in progress.

3.2 PREPARATION

A. The ENGINEER, with the assistance of the CONTRACTOR, will inspect and sound the areas involved to determine the extent of the chemical grouting involved. The CONTRACTOR shall outline the limits of the Work involved using a marking crayon, removable paint, or other suitable methods.
   1. Locations identified for concrete crack repair by epoxy injection or gravity feeding shall be repaired as specified in SECTION 03 63 00.
   2. Locations identified for concrete surface repair shall be repaired as specified in SECTION 03 93 00.

3.3 REPAIRS

A. Cracks:
   1. Roof and floor slabs:
      a. Prior to treatment, seal cracks in accordance with the instructions for spalls.
      b. Treat cracks greater than 0.010 inch in average width by direct injection with polyurethane grout.
   2. Walls:
      a. Form cracks 1/2 inch and greater in average width: Pour or pump using portland cement grout.
      b. Treat cracks greater than or equal to 0.010 inch in average width with polyurethane chemical grout.
      c. Seal the surface of cracks greater than or equal to 1/4 inch and less than 1/2 inch in average width in accordance with the instructions for spalls.
   3. Rout and seal cracks with polyurethane sealant as directed by the ENGINEER or as shown on the Drawings.

B. Spalls: Repair spalls greater than 1/8 inch in depth designated for repair as specified in SECTION 03 93 00.

C. Polyurethane Chemical Grout:
   1. Mix and apply in accordance with the Manufacturer's instructions.
   2. Crack preparation:
      a. Cracks and adjacent substrate shall be clean, sound, and free of frost.
      b. Remove bond-inhibiting materials from the surface by mechanical means including sand blasting, or high-pressure water blasting as approved.
      c. Prior to the application of chemical grout, moisture shall be present in the cracks.
      d. If concrete being injected contains insufficient moisture to activate the grout, inject the crack with a small amount of water prior to the application of the chemical grout.
   3. Surface sealing:
      a. For cracks in the roof and in the walls greater than or equal to 1/4 inch in average width, seal the surface of the crack prior to grouting.
      b. Sealing may be accomplished by one of three methods:
         1) Applying portland cement grout to the surface of the crack.
         2) Using a polyurethane chemical grout with additional accelerator, Component B, to form a seal on the surface of the crack.
         3) Installing an open-cell backer rod soaked with polyurethane chemical grout.
      c. Leave short segments of the crack, 1 inch to 2 inch, open at regular intervals to facilitate the venting of air and to allow visual verification of the complete crack filling.
      d. Cracks in the floor and in the walls that are less than 1/4 inch in average width may be injected directly with polyurethane chemical grout without surface sealing.
   4. Mixing:
      a. Slowly combine accelerator Component B with 5 gallons of Component A and mix thoroughly for 2 minutes with a low-speed, 400 rpm to 600 rpm, drill and paddle until uniform in color.
      b. Do not allow water to enter the mix.
      c. Avoid whipping air into the mix.
   5. Application:
      a. Drill 5/8 inch diameter holes along the side of the crack at 45-degree angles.
      b. Drill a hole to intersect the crack midway through the substrate.
      c. Space devices to achieve the travel of grout for pressure injection grouting between packers and to fill the crack to the maximum.
      d. Install injection packers in the holes.
      e. Pumping grout:
         1) Pump at a minimum of 250 psi for 45 seconds and then pause to allow material to flow into the cracks.
         2) Watch for material flow and water movement to appear on the surface.
         3) When movement stops, begin injection into the next packer.
         4) When sealing vertical cracks, begin injecting at the bottom of the crack and work vertically.
      f. If faster reaction time is needed or if grout is being pumped at a cold temperature, add additional accelerator to base resin, Component A, if allowed by the Manufacturer.
      g. Re-inject to ensure voids are properly sealed off.
   6. Finished surfaces: After grout has cured, use sharp-sided tools such as a putty knife or trowel to remove excess material from the injected surfaces.

D. Crack Sealing with Polyurethane Sealant:
   1. Mix and apply in accordance with the Manufacturer's instructions.
   2. Create a contraction joint on the surface of the concrete in the plane of the crack.
   3. Form joints by sawing 1/4 inch grooves 1/2 inch deep in the surface of the repair with an approved concrete saw or by routing the cracks with an angle grinder to a vee-notch of 3/8 inch width and depth.
   4. Begin sawing of the joint as soon as portland cement grout or polymer-modified portland cement mortar has hardened sufficiently to permit sawing without excessive raveling, usually 6 to 24 hours.
   5. Saw joints to the full depth before uncontrolled shrinkage cracking takes place.
   6. After the contraction joint is sawed, thoroughly clean the joint and the adjacent concrete surface.
   7. Insert a 1/4 inch diameter closed-cell backer rod to the full depth of the sawcut joint. Place bond breaker tape at the bottom of the vee-notched grooves.
   8. Apply polyurethane sealant:
      a. Before sealant is applied, clean the joint and the adjacent substrate.
      b. Install between a bond-breaking backer rod or tape and the concrete surface in accordance with the Manufacturer's instructions.
      c. Place the hand, air, or electric-powered gun nozzle into the bottom of the joint; fill the entire joint.
      d. Keep the tip of the nozzle in the sealant and continue with a steady flow of sealant proceeding from the nozzle to avoid air entrapment.
      e. Avoid overlapping sealant to eliminate entrapment or air.
      f. Tool as required to properly fill the joint.

3.4 QUALITY CONTROL

A. General: Samples of material submitted for inspection and possible testing shall be obtained from the materials provided or proposed for use on this Work.

B. Sampling and Testing of Grouts:
   1. Grouts shall be sampled and tested by the CONTRACTOR's testing laboratory to ensure materials are properly mixed and proper ingredients are incorporated.
   2. The frequency of tests shall be in accordance with ACI 301, Chapter 16, but may be increased by the ENGINEER.

3.5 CLEANING

A. Leave the finished Work and Work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03 93 00
CONCRETE REHABILITATION – REPAIR CONCRETE AND MORTAR

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for concrete rehabilitation – repair concrete and mortar.

B. Related Sections:

1. SECTION 03 15 05 – ANCHORING TO CONCRETE
2. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
3. SECTION 03 39 00 – CONCRETE CURING
4. SECTION 03 62 00 – NON-SHRINK GROUTING
5. SECTION 03 63 00 – EPOXY GROUTING
6. SECTION 03 65 00 – CHEMICAL GROUTING

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 308.1 – Specification for Curing Concrete
2. 347R – Guide to Formwork for Concrete

B. ASTM International (ASTM):

1. C 94 – Standard Specification for Ready-Mixed Concrete
2. C 309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

C. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice

D. International Organization for Standardization (ISO):

1. 9001 – Quality Management Systems – Requirements

1.3 SUBMITTALS

A. Submittals for Review:

1. Product data:
   a. Manufacturer's specifications, data sheets, recommendations, installation instructions, guarantees, test reports, and other pertinent data on materials showing compliance with contract requirements.
   b. List of items which have limited shelf life or require special handling, with a description of limitations and requirements.

B. Notarized certification or Project reference as specified in this Section.

C. A repair schedule detailing the type of repair product and the installation method for the various repair depths and surfaces.

D. Data sheet for any equipment to be used for removal of existing concrete.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. A minimum of 10 years of documented experience in the Work of this Section.
2. Have in existence, for a minimum of 10 years, a program of training, certifying, and technically supporting a nationally organized approved contractor program.
3. Company shall be ISO 9001 certified.

B. Installer Qualifications:

1. Approved by the Manufacturer.
2. Provide notarized certification from the Manufacturer attesting to the approved installer status or, if approved by the ENGINEER, provide five reference projects of similar size and complexity to the specified Work.

C. Provide a notarized certificate stating the repair material meets the specified requirements and have the Manufacturer's current printed literature on the specified product.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Deliver materials in the Manufacturer's original, unopened, undamaged containers with the identification labels intact.

C. Store tightly sealed materials off the ground and away from moisture, direct sunlight, extreme heat, and freezing temperatures.

1.6 SITE CONDITIONS

A. Ensure that substrate surface and ambient air temperature are a minimum of 45˚F and rising at the time of application and remain above 45˚F for at least 1 day after application. Ensure that frost or frozen surfaces are thawed and dry.

B. Do not apply material if snow, rain, fog, and mist are anticipated within 12 hours after application. Allow surfaces to attain the temperature and conditions specified before proceeding with the application.

C. Schedule Work appropriately or supply supplemental heat sources that will increase the Work environment to an acceptable temperature.

D. Do not apply over sealant joints, control joints, or other materials that will be affected by solvent.

E. Follow the Manufacturer recommendations for conditions of application.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Portland Cement Repair Concrete:

1. Vertical and horizontal surfaces:
   a. BASF Building Systems, MasterEmaco, S 466CI (Corrosion Inhibiting)
   b. Sika Corporation, Sikacrete 211

B. Polymer-Modified Repair Mortar:
   1. Vertical and overhead surfaces:
      a. Sika Corporation, SikaTop 123 Plus (Corrosion Inhibiting)
   2. Horizontal surfaces:
      a. Sika Corporation, SikaTop 122 Plus
C. Polymer-Modified Protective Slurry Mortar:
   1. Vertical and horizontal surfaces:
      a. Sika Corporation, SikaTop Seal 107

2.2 MATERIALS
A. General:
   1. Use only approved materials in accordance with the Contract Documents.
   2. Materials are subject to inspection and tests at any time during preparation or use.
   3. Obtain approval for the source of supply of each material before delivery or use.
B. Portland Cement Repair Concrete:
   1. Description:
      a. One-component portland cement repair concrete containing coarse aggregate.
      b. Suitable for 1 inch to 8 inch repair depth.
      c. Flowable repair concrete mix suitable for horizontal and vertical. Used for formed concrete repairs.
C. Polymer-Modified Repair Mortar:
   1. Description:
      a. Two-component polymer modified cementitious non-sag repair mortar.
      b. Suitable for 1/8 inch to 1 1/2 inch repair depth per lift, extendable to 4-inch lifts at horizontal surfaces.
      c. Hand-applied repair mortar suitable for horizontal, vertical, and overhead surfaces.
   2. Aggregate for extending horizontal lift thickness:
      a. Sized in accordance with the Manufacturer's instructions.
      b. Non-reactive, clean, and well-graded.
      c. SSD at time of mixing.
D. Polymer-Modified Protective Slurry Mortar:
   1. Description:
      a. Two-component polymer-modified cementitious slurry mortar.
      b. Hand-applied or spray-applied for increased dampproofing, waterproofing, and abrasion protection.
E. Water:
   1. Potable water.
   2. In accordance with ASTM C 94.
   3. Free from sewage, oil, acids, strong alkalis, vegetable matter, clay, loam, or other deleterious substance that might affect the grout performance.
F. Accessories:
   1. Adhesive for post-installed rebar: As specified in SECTION 03 15 05.
   2. Curing compounds: In accordance with ASTM C 309, Type ID.

PART 3 EXECUTION

3.1 GENERAL
A. Furnish labor, materials, and services necessary for, and incidental to, completion of the Work in accordance with the Contract Documents.
B. Use equipment of sufficient size to meet the requirements of the Work and to produce satisfactory Work.
C. Work is subject to the inspection and approval of the ENGINEER.
D. Employ a sufficient force of workmen of such experience and ability that Work can be completed in a satisfactory and workmanlike manner.
E. Provide notice to the ENGINEER 1 day prior to performing repair Work to permit the ENGINEER to review the surface preparation and Work in progress.

3.2 PREPARATION
A. The ENGINEER, with the assistance of the CONTRACTOR, will inspect and sound the areas involved to determine the extent of the Work involved. Locations and extents of concrete repair and concrete protection with polymer-modified protective slurry mortar shall be determined and documented. The CONTRACTOR shall outline the limits of the Work involved using a marking crayon, removable paint, or other suitable methods.
   1. Locations identified for concrete crack repair by epoxy grouting shall be repaired as specified in SECTION 03 63 00.
   2. Locations identified for concrete crack repair by chemical grout injection shall be repaired as specified in SECTION 03 65 00.
B. The preparation required for the concrete and mortar repair patches shall be performed in accordance with the Contract Documents and the Manufacturer's recommendations.
C. Place polymer-modified protective slurry mortar at locations determined during the pre-repair inspection.

3.3 REPAIRS
A. Concrete Surface Repairs:
   1. Areas of deteriorated and unsound concrete, as determined during the inspection, shall be removed as follows:
      a. Remove loose concrete.
      b. Removal of concrete shall extend 2 inches to 4 inches beyond the outer boundary mark of unsound concrete.

c. The areas removed shall be rectangular shaped in plan view.
d. The edges of the patch area shall be perpendicular and slightly undercut 1 inch deep or as shown on the Drawings. This shall be accomplished by saw cutting. Feathered edges will not be permitted. Care shall be taken to prevent damage to the existing reinforcing steel.
e. Jackhammers are not to be used near any concrete that is to remain in place or on concrete sections where a portion is to remain.
f. Where possible, concrete shall be removed completely around exposed reinforcing steel such that a 3/4 -inch clearance from the in-situ concrete is obtained.
g. Removal of concrete around and beneath the reinforcing steel shall be performed using chipping hammers not in excess of a 15 lb rating.
h. During the removal process, care shall be exercised to avoid cracking and otherwise damaging the surrounding sound concrete.
i. Concrete removed and surface preparation within the repair area shall provide an exposed aggregate surface with a minimum surface profile of ±1/4 inch.
j. The depth of concrete removed within the repair area shall comply with the placement range of the selected repair products.

2. Following the removal of deteriorated and unsound concrete and prior to cleaning the patch area, remove loose concrete from the Work area and leave the area broom clean.
3. Exposed reinforcing steel shall be thoroughly prepared by mechanical cleaning or blast cleaning to remove traces of rust. The steel shall be high pressure washed with clean water after cleaning.
4. The patch area shall be thoroughly cleaned by sandblasting or high-pressure water blasting, 3,000 psi minimum, to accomplish the following:
   a. Removal of remaining loose and unsound concrete and dirt, debris, and other contaminants which may impair adhesion of the concrete and mortar repair.
   b. Removal of loose rust, scale, and unsound concrete from the exposed reinforcing steel.
5. Presoak the prepared concrete surface to provide a SSD condition.

B. Reinforcement Steel:
1. Reinforcing steel which has lost more than 20% of its original area at any given point along its length shall be repaired as required by the ENGINEER or as follows:
   a. Supplement the existing deteriorated reinforcing steel with new steel of a size equal to the area of steel lost due to degradation.
   b. Existing reinforcing steel shall remain in place.
   c. Supplemental reinforcing steel shall be placed following the cleaning of the patch area and in accordance with the CRSI Manual of Standard Practice and shall be securely tied to prevent displacement during the placement of the concrete and mortar repair.

C. Repair Methods:
1. For horizontally-oriented repair depths greater than 1 1/2 inches and less than 4 inches, repair with formed flowable portland cement repair concrete or polymer-modified repair mortar extended with aggregate, as shown on the Drawings.
2. For repair depths less than or equal to 1 1/2 inches, repair with polymer-modified repair mortar extended with aggregate as required.
3. For repair depths greater than 4 inches and less than 8 inches, repair with formed flowable portland cement repair concrete.

D. Portland Cement Repair Concrete:
1. Surface preparation: As specified in this Section.
2. Reinforcement steel: As specified in this Section.
3. Forms:
   a. Forms for the placement of concrete shall be in accordance with ACI 347R.
   b. Construct forms so they do not deflect during the pumping of grout.
   c. Provide vents with caps in forms as recommended by the Grout Manufacturer to release air during grouting.
   d. Run a bead of sealant around the edge of the form to prevent the leakage of grout.
   e. Check forms for watertightness by filling with water.
4. Mixing and application:
   a. Mix and apply in accordance with the Manufacturer's recommendations.
      1) In conditions where formwork cannot be filled with water, thoroughly hose down concrete substrates with clean water to achieve an equal level of SSD immediately before the placement of the repair concrete.
      2) Immediately after mixing:
         a) Scrub a bond coat of repair concrete between 1/16 inch and 1/8 inch thick into the prepared surface with a stiff bristle brush.
         b) Apply only an amount of bond coat that can be covered with the repair concrete before the repair concrete dries.
      3) Begin pumping through the lowest point in the form with a variable pressure pump.
      4) Pour or pump until there is a steady flow of grout from the bottom vent.
      5) Cap off the bottom vent and continue pouring or pumping grout until there is steady flow of grout from the adjacent vent.
      6) Continue capping vents as soon as a steady flow of grout appears.

7) Continue pumping until there is a 3 psi to 5 psi increase in normal line pressure.

5. Form removal and curing:
   a. Apply an evaporation reducer after finishing.
   b. Allow proper curing of repair concrete, conducted in accordance with ACI 308.1.
   c. Apply curing compound or mist cure for a minimum of 7 days.
   d. If a repaired area will receive finish material, wet-cure the repair surface.
   e. Leave the formwork in place until the repair mortar reaches a compressive strength of 2,500 psi or the strength specified by the ENGINEER.
6. Finished surfaces:
   a. Immediately remove the defective Work disclosed after the forms have been removed and replace at no cost to the OWNER.
   b. Drypack anchor holes with Category II non-shrink grout as specified in SECTION 03 62 00.
   c. Place and finish concrete as specified in SECTION 03 30 00.
   d. Cure concrete as specified in SECTION 03 39 00.

E. Polymer-Modified Repair Mortar:
1. Mix and apply in accordance with the Manufacturer's recommendations.
2. Surface preparation: As specified in this Section.
3. Mix and apply in accordance with the Manufacturer's recommendations.
4. Curing: Allow proper curing of the repair concrete, conducted in accordance with ACI 308.1.

F. Polymer-Modified Protective Slurry Mortar:
1. Mix and apply in accordance with the Manufacturer's recommendations.
2. Surface preparation:
   a. Surface shall be clean, free from grease, oil, and loosely adhering particles.
   b. Surface shall be SSD with no standing water at the time of application.
3. Mixing and application:
   a. Mix and apply in accordance with the Manufacturer's recommendations.
   b. Mixing:
      1) Mechanically mix with low-speed (400 rpm to 600 rpm) drill and mixing paddle.
      2) Mix Components A and B to uniform consistency.
   c. Application:
      1) Apply with brush, trowel, notched trowel, or spray equipment in accordance with the Mortar Manufacturer's requirements working the material well into the prepared substrate, filling pores and voids.
      2) Apply an initial coat of 40 mil minimum, 80 mil maximum thickness, and allow to harden for 6 to 8 hours.
      3) Apply a final coat of 40 mil minimum, 80 mil maximum thickness, and allow to harden.
4. Curing: Protect newly applied material from direct sunlight, wind, rain, and frost.

3.4 PROTECTION

A. Protect the repair concrete and the repair mortar system from damage during construction.
B. Protect the repair concrete and the repair mortar system from freezing for 1 day after the application.
C. Prior to installation of the finish topping, protect the surface from damage by the use of plywood or other suitable protection course until the Substantial Completion date.

3.5 QUALITY CONTROL

A. General: Samples of material submitted for inspection and possible testing shall be obtained from the stock on-hand that is provided or proposed for use on this Project.
B. Sampling and Testing of Portland Cement Repair Concrete:
1. Repair concrete shall be sampled and tested by the CONTRACTOR's testing laboratory to ensure that materials are properly mixed and proper ingredients are incorporated.
   a. Compression strength test for applicable repair medium.
   b. Tensile bond test for applicable repair medium.
2. Frequency of tests: Perform tests for portland cement repair concrete used at repair locations where the repair area is greater than or equal to 20 sf. The frequency of tests may be increased by the ENGINEER.

C. Testing Concrete Repairs: After the concrete repair is completed, sound the concrete repair area. Remove and replace delaminated and unsound concrete repairs at the CONTRACTOR's expense.

3.6 CLEANING

A. Clean wet repair mortar material from tools and equipment with water. Remove cured materials mechanically.
B. Clean and properly dispose of debris remaining on the Project site related to the application.
C. Remove temporary coverings and protection from adjacent Work areas.

END OF SECTION

SECTION 04 21 00
CLAY MASONRY UNIT

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for clay masonry units.
- B. Related Sections:
  1. SECTION 05 50 00 – METAL FABRICATIONS
  2. SECTION 07 19 00 – WATER REPELLENTS
  3. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  3. A 951 – Standard Specification for Masonry Joint Reinforcement
  4. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
  5. A 1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  6. C 67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
  7. C 144 – Standard Specification for Aggregate for Masonry Mortar
  8. C 150 – Standard Specification for Portland Cement
  9. C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by means of the Guarded-Hot-Plate Apparatus
  10. C 207 – Standard Specification for Hydrated Lime for Masonry Purposes
  11. C 216 – Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
  12. C 270 – Standard Specification for Mortar for Unit Masonry
  13. C 404 – Standard Specification for Aggregates for Masonry Grout
  14. C 476 – Standard Specification for Grout for Masonry
  15. C 652 – Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale)
  16. C 1019 – Standard Test Method for Sampling and Testing Grout for Masonry
  17. C 1314 – Standard Test Method for Compressive Strength of Masonry Prisms
  18. D 2000 – Standard Classification System for Rubber Products in Automotive Applications
  19. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  20. E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials
- B. Brick Industry Association (BIA):
  1. Technical Notes on Brick Construction 1 – Hot and Cold Weather Construction
  2. Technical Notes on Brick Construction 20 – Cleaning Brickwork
- C. International Code Council (ICC):
  1. International Building Code (IBC), Chapter 21, Section 2105 – Quality Assurance

1.3 PRE-INSTALLATION MEETINGS
- A. Convene at the site 4 weeks prior to beginning the Work of this Section.
- B. Attendance: OWNER, ENGINEER, CONTRACTOR, Structural Engineer, Masonry Subcontractor, Masonry Subcontractor's Cleaning Installer, and related trades.
- C. Review and discuss: Contract Documents, site conditions, scheduling, and other matters affecting the application.
- D. Schedule the meeting after the review and approval of submittals for the Work of this Section but prior to the erection of the mockup.
- E. Provide meeting minutes.

1.4 SUBMITTALS
- A. Product Data: Information on reinforcing and anchors including sizes, profiles, materials, and finishes.
- B. Samples:
  1. Brick showing the full color and texture range: Three.
  2. Colored mortar: 1/2 inch by 1/2 inch by 3 inches long.
- C. Quality Control Submittals:
  1. Clay masonry unit: Certificates of compliance with specifications for clay unit grades, types, and classes.
  2. Mortar: Proposed design mortar mixes for each type of mortar, and test reports indicating mortar compliance in accordance with ASTM C 270.
  3. Grout: Mix designs for grout for masonry reinforcement; test reports for grout materials in accordance with ASTM C 476 from an independent testing laboratory certifying conformance to the grout strength requirements.
  4. Core insulation: Certificates of compliance from an independent testing laboratory that core insulation meets fire hazard classification requirements in accordance with ASTM E 119.

1.5 QUALITY ASSURANCE
- A. Installer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Masonry Units: In accordance with BIA and ASTM C 216 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.

C. Testing and Inspection: The ENGINEER will provide independent field inspection and testing of masonry Work in accordance with ICC IBC Chapter 21, Section 2105. The independent inspector will be present and will inspect the Work during the preparation of masonry wall prisms, sampling, the placing of hollow block units, the placement of reinforcement, and immediately prior to and during grouting of masonry on the Work.
   1. Masonry units: Inspect masonry units prior to and during installation for compliance with the specified requirements.
   2. Masonry assemblies:
      a. Determine the F'm by the prism method, in accordance with ASTM C 1314.
         1) Provide a set of five prisms made and tested prior to the start of construction for each masonry material.
         2) During construction, provide one set of three prisms for each 5,000 sf of masonry wall.
         3) Minimum compressive strength at 28 days: 2,000 psi.
      b. Verify the dimensions and the condition of grout spaces and the type, quantity, and placement of reinforcement during installation and just prior to the closing of cleanouts.
      c. Verify the type, quantity, and installation of reinforcement, anchors, and ties.
      d. Inspect the placement of grout:
         1) Verify grout spaces are clear and ready to receive grout.
         2) Verify grout is properly consolidated and then reconsolidated after 15 minutes using mechanical vibrators.
      e. Inspect the installation of mortar: Verify head and bed joints are installed as specified in this Section.

D. Grout: Mold and test one set of compressive strength cubes in accordance with ASTM C 1019 for each 5,000 sf of masonry wall area or fraction thereof.

E. Efflorescence: Protect masonry construction to prevent efflorescence. Take necessary measures to eliminate moisture from entering incomplete walls that have not received parapet copings.

F. Mockup:
   1. Size: 6 feet high by 8 feet wide with one 90 degree corner, a 2 foot wide return wall, and one finished opening.
   2. Show:
      a. Masonry color and texture range.
      b. Mortar joint size, color, and profile.
      c. Each bond pattern.
      d. Reinforcing.
      e. Flashings and weeps.
      f. Masonry control joint.
   3. Demonstrate:
      a. The ability to keep insulation and grout isolated and in certain cells in any sequence of placement.
      b. Materials shall be restricted to cells and bond beams intended to receive each material.
      c. Construction within the required tolerances for wall plumb, joint construction, and bond pattern.
   4. Locate with the primary orientation facing south.
   5. Allow 7 to 14 days after panel erection for mortar to fully cure prior to review by the ENGINEER.
   6. Clean the panel within the specified time requirements for cleaning prior to review by the ENGINEER.
   7. The approved mockup shall indicate the quality of, and will be the basis for acceptance of, the permanent masonry construction. Leave the mockup in place until masonry Work is complete and accepted by the ENGINEER to ensure minimum deviation from the sample panel.
   8. After review and acceptance by the ENGINEER, apply water repellent as specified in SECTION 07 19 00 to establish coverage rates and warranty.
   9. The approved mockup shall not remain as part of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Store masonry off the ground; prevent contact with materials that could cause staining or damage.
   B. Protect reinforcement and anchors from corrosion.
   C. Deliver cement and lime in the Manufacturer's original, unopened packages or containers.
   D. Protect materials from moisture absorption and damage; reject damaged containers.
   E. Store aggregate to prevent the inclusion of foreign matter.

1.7 SITE CONDITIONS
   A. Load Application: Do not apply any structural loads for at least 3 days after completing masonry columns or walls.
   B. Environmental Requirements – General: In accordance with BIA's Technical Notes on Brick Construction 1.
   C. Hot Weather Requirements: If ambient temperature is over 95°F or relative humidity is less than 50%, protect from direct sun and wind exposure for a minimum of 2 days after installation.
   D. Cold Weather Preparation:
      1. Remove ice and snow that has formed on top of the foundation wall or the base construction upon which masonry will set.
      2. Apply heat until the top surface is dry to the touch. Do not build on frozen Work.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
   A. Through Wall Brick:
      1. Interstate Brick, Atlas
   B. Face Brick:
      1. Interstate Brick, Modular
   C. Clay Masonry Units:
      1. Acme Brick Company
      2. Belden Brick Company

3. Brick, Inc.
4. Endicott Clay Products
5. Glen-Gery Corporation
6. Interstate Brick
7. Summit Brick Company

D. Masonry Accessories:
1. Heckmann Building Products, Inc.
2. Hohmann and Barnard, Inc.

E. Cement:
1. Lehigh Hanson
2. Martin Marietta Materials, Inc.

F. Lime:
1. Carmeuse Lime and Stone
2. Graymont Limited
3. Lhoist North America

G. Preblended Mortars and Grouts:
1. The Quikrete Companies
2. US Mix Company

H. Mortar Colorants:
1. Davis Colors
2. Lanxess Corporation
3. Solomon Colors, Inc.

I. Foamed-in-Place Insulation for Through-Wall Brick:
1. Tailored Chemical Products, Inc., Core-Fill 500 Foam Insulation

J. Veneer Wall Ties for Concrete Cavity Wall Backup:
1. Heckmann Building Products, Inc., No. 75 Pos-I-Tie System
2. Hohmann and Barnard, Inc., Thermal Concrete 2-Seal Tie

K. Veneer Wall Ties for Masonry Cavity Wall Backup:
1. Heckmann Building Products, Inc., Ladder Pintle Eye Wall 300
2. Hohmann and Barnard, Inc., 170 M-L Truss Adjustable Eye-Wire Joint Reinforcement

L. Veneer Wall Ties at Metal or Wood Stud Walls with Sheathing and Cavity Insulation:
1. Heckmann Building Products, Inc., Pos-I-Tie System
2. Hohmann and Barnard, Inc., 2-Seal Tie

M. Dovetail Anchors for Concrete, Masonry, and Metal or Wood Stud Walls with Sheathing and no Cavity Insulation:
1. Heckmann Building Products, Inc., 315-C/316
2. Hohmann and Barnard Inc., DW-10/Vee Byna Tie

N. Through Wall Copper Flashings:
1. Dur-O-Wal, DA 1507 copper coated flashing
2. Hohmann and Barnard, Inc., H&B C-Coat flashing

O. Single and Double Wythe Joint Reinforcement:
1. Heckmann Building Products
2. Hohmann and Barnard, Inc.

P. Rubberized Asphalt Flashing:
1. GCP Applied Technologies, Perm-A-Barrier
2. Wire-Bond, AquaFlash 500

Q. Mortar Dropping Control:
1. Mortar Net USA, MortarNet

R. Weeps:
1. Mortar Net USA, Weep Vents

S. Reinforcing Bar Positioners:
1. Hohmann and Barnard, Inc., RB Rebar Positioner

T. Grout Screen:
1. Hohmann and Barnard, Inc., MGS Mortar/Grout Screen
2. MasonPro, Grout Stop

U. Preformed Control Joint:
1. Hohmann and Barnard, Inc., RS Series Rubber Control Joint
2. Wire-Bond, Rubber Control Joint

V. Cleaner:
1. ProSoCo, Sureklean 600
2. ProSoCo, Sureklean Vana Trol

2.2 MATERIALS

A. Through Wall Brick:
1. In accordance with ASTM C 652, Grade SW, Type HBX.
2. Size: 7 5/8 inches by 3 5/8 inches by 15 5/8 inches.
3. Color: To be selected from the Manufacturer's standards.
4. Special shapes: As shown on the Drawings.
5. Provide solid units where holes would otherwise occur on exposed faces.

B. Face Brick:
   1. In accordance with ASTM C 216, Grade SW, Type FBS.
   2. Size: 3 5/8 inches by 2 1/4 inches by 7 5/8 inches actual.
   3. Color: To be selected from the Manufacturer's standards.
   4. Special shapes: As shown on the Drawings.
   5. Provide solid units where holes would otherwise occur on exposed faces.

C. Mortar and Grout:
   1. Portland cement:
      a. In accordance with ASTM C 150, Type I.
      b. For exposed surfaces, provide cement from one source throughout the Work.
   2. Aggregate:
      a. Mortar: Standard masonry type, in accordance with ASTM C 144.
      b. Grout: In accordance with ASTM C 404.
      c. For exposed surfaces, provide aggregate from one source throughout the Work.
   3. Lime: In accordance with ASTM C 207, Type S.
   4. Colorant: Pure mineral oxide type; color to be selected from Manufacturer's full color range.
   5. Water: Clean and free from oils, acids, alkalis, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.

D. Mortar Type: As shown on the Drawings.

E. Grout:
   1. Grout Mix:
      a. Fine and coarse grout, in accordance with ASTM C 476.
      b. Compressive strength: Minimum 2,000 psi at 28 days.
      c. Slump: 9 inches, ±1 inch.
   2. Mixing:
      a. Mix grout in accordance with ASTM C 476.
      b. Thoroughly mix ingredients in the quantities needed for immediate use.
      c. Mix dry ingredients mechanically until uniformly distributed; add water to achieve a workable consistency.
      d. Use grout within 2 1/2 hours after initial mixing at ambient temperatures below 80°F and within 1 1/2 hours after initial mixing at ambient temperatures over 80°F.
      e. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without the ENGINEER's written approval.

F. Masonry Core Insulation:
   1. Foamed-in-place insulation for through-wall brick:
      a. An amino-plast foam two-component thermal insulation of plastic resin and catalyst foaming agent surfactant.
      b. Surface burning characteristics: Maximum flame spread, smoke developed, and fuel contributed of 0, 5, and 0, respectively, when tested in accordance with ASTM E 84.
      c. Combustion characteristics: Shall be noncombustible, Class A building material.
      d. Thermal values: R-value of 4.91 per inch at 32°F mean; in accordance with ASTM C 177.
   2. Loose fill insulation, EPS insulation core inserts, or other types of insulation.

2.3 ACCESSORIES

A. Single Wythe Joint Reinforcement:
   1. Truss or ladder type, galvanized steel wire in accordance with ASTM A 951, 9 gauge side rods with 9 gauge cross ties.
   2. Width: Nominal wall thickness less 2 inches.
   3. Corner and tee fittings: The type to match reinforcement.
   4. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

B. Double Wythe Joint Reinforcement:
   1. Ladder type, galvanized steel wire in accordance with ASTM A 951, 9 gauge side rods with 9 gauge cross ties.
   2. Width: Nominal wall thickness less 2 inches.
   3. Corner and tee fittings: Type to match reinforcement.
   4. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

C. Veneer Wall Ties for Concrete Cavity Wall Backup:
   1. Self-drilling screw with 3/16 inch diameter triangle wire tie, in accordance with ASTM A 1064, of length required to provide minimum 2 inch embedment into mortar and no closer than 3/4 inch to face of exposed masonry; barrel consists of one-piece screw, washer, flanged head and eye to receive wire tie and is designed to seat directly on structural backup, with flanged head covering fastener hole.
   2. Barrel shaft length to suit conditions.
   3. Finish:
      a. Wire tie: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.
      b. Barrel material: 92% Zamac 2 zinc.

D. Veneer Wall Ties for Masonry Cavity Wall Backup:
   1. Truss type, galvanized steel wire in accordance with ASTM A 951, 9 gauge side and cross rods, and 3/16-inch pintle rods and eyes in accordance with ASTM A 1064.
   2. Corner and tee fittings: Type to match reinforcement.
   3. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

E. Veneer Wall Ties at Metal or Wood Stud Walls with Sheathing and Cavity Insulation:
   1. Self-drilling screw with 3/16 inch diameter triangle wire tie, in accordance with ASTM A 1064, of length required to provide minimum 2 inch embedment into mortar and no closer than 3/4 inch to face of exposed masonry; barrel consists of one-piece screw washer, flanged head and eye to receive wire tie and is designed to seat directly on cavity insulation, with flanged head covering fastener hole.
   2. Barrel shaft length to accommodate sheathing and insulation thickness.
   3. Finish:
      a. Wire tie: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.
      b. Barrel material: 92% Zamac 2 zinc.

F. Dovetail Anchors for Concrete, Masonry, and Metal or Wood Stud Walls with Sheathing and No Cavity Insulation:
   1. Dovetail-shaped wire tie, 3/16 inch, in accordance with ASTM A 1064, with 12 gauge, steel anchor plate, in accordance with ASTM A 1008, accommodating vertical height adjustment of wire tie.
   2. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.

G. Copper Through Wall Flashings: A 5 ounce electrolytic copper sheet uniformly coated on both sides with acid-proof alkali-proof elastic bituminous compound, factory-applied, weighing no less than 6 ounces psf.

H. Rubberized Asphalt Flashing: Cold-applied self-adhesive membrane consisting of an 8 mil thickness high density cross-laminated PE film integrally bonded to a 32 mil thickness rubberized asphalt, with a removable release liner.

I. Mortar Dropping Control:
   1. High-density PP, nylon, and recycled polyester material in a 90% open mesh weave fabric.
   2. Size: 1 inch wide or 2 inches wide to fit cavity by 10 inches high by 60 inches long.

J. Weeps:
   1. High-density PP, nylon, and recycled polyester material in a 90% open mesh weave fabric.
   2. Size: 2 1/4 inches by 3 1/2 inches by 1/2 inch.
   3. Color: To be selected from the Manufacturer's standards.
   4. Spacing: 24 inches on center unless otherwise shown on the Drawings.

K. Reinforcing Bars: Deformed carbon steel, in accordance with ASTM A 615, Grade 60.

L. Reinforcing Bar Positioners:
   1. Steel wire, 9 gauge, in accordance with ASTM A 1064.
   2. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

M. Grout Screen: Monofilament PP mesh screen.

N. Preformed Control Joint: Flexible rubber compound, black color, in accordance with ASTM D 2000.

O. Joint Sealants: As specified in SECTION 07 92 00.

P. Loose Steel Lintels: As specified in SECTION 05 50 00.

Q. Cleaner: The type suited to surfaces and conditions and recommended by the Masonry Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Wet brick having an absorption rate in excess of 20 g/30 sq in/minute in accordance with ASTM C 67 so the absorption rate when laid does not exceed this amount.

B. Cover the wall cavity and the masonry unit cores when Work is not in progress to keep water from entering the wall cavity or the cores. Provide sufficient ballast to keep the cover in place.

C. Pull back scaffold planks next to the wall to avoid splash on the wall. Tip planks daily to remove excess mortar and dirt.

D. Remove mortar droppings before they harden. After the mortar sets, the wall shall be brushed daily.

E. Prevent grout or mortar from staining the face of masonry to be left exposed. If grout or mortar contacts the face of such masonry, remove it immediately.

3.2 INSTALLATION

A. Establish lines, levels, and courses shown on the Drawings. Protect from displacement.

B. Maintain masonry courses to uniform dimensions. Form horizontal and vertical joints of uniform thickness.

C. Lay masonry in running bond unless otherwise shown on the Drawings. Course three brick units and three mortar joints to equal 12 inches for wall brick and 8 inches for modular brick.

D. Lay masonry plumb and level. Do not adjust masonry units after mortar has set.

E. Lay solid masonry units in full mortar bed, with full head joints. Lay hollow masonry units with face shell bedding on the head and bed joints.

F. Closures shall be rocked into place with the head joint mortar thrown against the two adjacent units in place.

G. Do not butter corners or furrow joints.

H. Keep the cavity or air space and the face of masonry free of mortar droppings.

I. Machine cut masonry with straight cuts and clean edges; prevent oversized or undersized joints. Discard damaged units. Do not expose cut cells.

J. When joining fresh masonry to partially set masonry, remove loose masonry and mortar; clean and lightly wet the exposed surface of set masonry.

K. Stop horizontal runs by racking back the normal bond unit in each course. Toothing is not permitted.

L. Fully grout steel door frames set into the masonry as the wall is being built.

M. Horizontal Reinforcement:
   1. Place reinforcement at a maximum of 16 inches on center vertically, at the topmost course, and at the first two courses above and below openings.
   2. Extend a minimum of 24 inches each side of openings.
   3. Center reinforcing in the wall.
   4. Lap ends 6 inches at a minimum; use fabricated tee and corner fittings at corners and intersections.

N. Control Joints:
   1. Do not continue horizontal joint reinforcement through control joints.
   2. Keep joints free from mortar and grout.
   3. Install preformed control joint material.
   4. Install joint backing and joint sealer at control joints as specified in SECTION 07 92 00.
   5. Form expansion joint as shown on the Drawings.
O. Masonry Core Insulation: Install insulation in cores of ungrouted exterior walls.
P. Finishing Mortar Joints:
   1. Exposed locations: Tool joints to a concave profile.
   2. Concealed locations: Strike joints flush.
   3. In general, use steel jointers. However, SST jointers shall be used where white or a light colored mortar is used.
   4. The use of a 16 inch or longer sled runner is required at horizontal joints.
   5. Fill joints in masonry work with mortar as each course is laid.
   6. Fill bed and head joints solidly with mortar. The thickness of mortar joints shall be uniform and true to dimensions.
Q. Reinforcing Bars:
   1. Position reinforcing accurately and hold securely in place to prevent displacement. Maintain a minimum 1 inch space between masonry and reinforcing.
   2. Grout lifts shall not exceed 6 times the width of the grout space, with a maximum of 48 inches high.
   3. Vibrate grout during and after placement to ensure complete filling.
   4. Stop grout 1 1/2 inches below the top of masonry if grouting is stopped for 1 hour or more, except where completing the grouting of a finished wall.
R. Flashings:
   1. Install flashing with the outer edge flush with the outside face of masonry; extend up substrate 8 inches at a minimum.
   2. Provide flashing in lengths as long as practicable.
   3. Lap end joints 4 inches at a minimum and seal.
   4. Form end dams where flashing is stopped or interrupted.
S. Weeps:
   1. Locate weeps in head joints in the first course above flashings at a maximum of 24 inches on center.
   2. Set weeps flush with the exterior face of masonry.
T. Install mortar dropping control continuously in cavities above flashings.
U. Foamed-In-Place Insulation – Through-Wall Brick:
   1. Install foamed-in-place insulation from the interior, prior to the installation of interior finish work, in accordance with the Manufacturer's instructions.
   2. Fill open cells and voids in exterior hollow concrete masonry walls and where shown on the Drawings.
   3. At walls receiving interior wall finishes, pump the foam through a horizontal row of 5/8 inch holes that are drilled into the mortar joints every 8 inches on center at an approximate height of 5 feet from the finished floor level around the entire wall. Repeat this method at an approximate height of 10 feet above the first horizontal row of holes if the insulated wall height is higher than 16 feet above the finished floor level. Patch holes and retool course.
   4. At exposed through-wall brick walls receiving no covering finish, pump the foam into the top of the open cell of the through-wall brick wall at intervals recommended by the Manufacturer. Repeat this method as the wall is constructed. Fill open cells that are below windowsills.
V. Through-Wall Brick Insulation: Loose fill insulation, EPS insulation core inserts, or other types of insulation.
W. Installation Tolerances (maximum variation from):
   1. Alignment of columns and pilasters: ±1/4 inch.
   2. Alignment face to face of adjacent units: ±1/8 inch.
   3. Vertical alignment of head joints: ±1/2 inch in 10 feet.
   4. True plane of wall: ±1/4 inch in 10 feet and 3/8 inch in 20 feet or more.
   5. Plumb: ±1/4 inch in 10 feet noncumulative and 1/4 inch in 20 feet or more.
   6. Level coursing: ±1/8 inch in 3 feet; 1/4 inch in 10 feet; 1/2 inch in 30 feet.
   7. Variation of the linear building line from its established position in the plan: Shall not exceed 1/2 inch in any bay or 20 foot maximum, nor shall it exceed 3/4 inch in 40 feet or more.
   8. Joint thickness: ±1/8 inch.
   9. Cross-sectional thickness of walls: ±1/4 inch.
X. Cold Weather Requirements:
   1. Implement cold weather construction procedures when ambient temperature or the temperature of masonry units falls below 40°F.
   2. When ambient temperature is between 25°F and 20°F, use heat sources on both sides of the masonry under construction. Install wind breaks when the wind velocity is in excess of 15 mph.
   3. When ambient temperature is below 20°F, provide an enclosure for the masonry under construction and use heat sources to maintain temperatures above 32°F within the enclosure.
   4. When the mean daily temperature is between 40°F and 25°F, protect completed masonry from rain or snow by covering it with a weather resistive membrane for 1 day after construction.
   5. When the mean daily temperature is between 25°F and 20°F, completely cover completed masonry with insulating blankets, or equal protection, for 1 day after construction.
   6. When mean daily temperature is below 20°F, maintain the masonry temperature above 32°F for 1 day after construction by enclosure with supplementary heat.
   7. Remove and replace Work that has been frozen or damaged by freezing conditions.

8. Failure to follow cold weather procedures will be construed as evidence that masonry has frozen. Such masonry shall be removed and replaced.

Y. Cold Weather Mortar and Grouting Requirements:
1. The temperature of masonry to be grouted shall be greater than 35°F when grout is placed. Place grout in masonry at a minimum temperature of 70°F and at a maximum temperature of 120°F. Maintain grouted masonry above 35°F for 1 day following the placement of grout.
2. Heat sand and mixing water when the air temperature is below 40°F in order to provide mortar and grout temperatures between 40°F and 120°F when used.
3. Do not heat sand or water above 120°F.

3.3 PROTECTION:

A. Wall:
1. During erection, cover the tops of partially completed walls with a strong waterproof membrane at the end of each day or at Work stoppage.
2. Extend the cover a minimum of 24 inches down both sides and hold securely in place.

3.4 CLEANING

A. General: Monitor, log progress of completion, and schedule cleaning of exterior masonry walls in accordance with the following:
1. The cleaning process for completed exterior masonry walls shall occur a minimum of 7 days and a maximum of 14 days after the erection of the wall.
2. Schedule cleaning operations to coincide within the stated period. Include multiple operations at time junctures as required.

B. Preparation:
1. Point holes in exposed masonry and cut out and repoint defective joints.
2. Remove efflorescence using the appropriate specified cleaner, but in a very diluted mixture. Consult the Cleaner Manufacturer for appropriate dilution rates.

C. Protection: Provide coverings and masking to protect plant materials and other non-masonry surfaces from damage.

D. Environmental Conditions:
1. Ambient and substrate temperatures shall be above 40°F to proceed with cleaning operations. If ambient and substrate temperatures are below 40°F, heat the water to a minimum of 120°F and a maximum of 200°F to achieve acceptable environmental conditions.
2. Conduct cleaning operations at a time when the masonry surfaces will have adequate time to thoroughly dry without freezing.

E. Test:
1. Test cleaning methods on a sample wall panel or portion of the building wall as directed. The test area shall be located in an unobtrusive area.
2. The fundamental consideration for cleaning procedures is to ensure there is no damage to the masonry substrates while achieving a wall that is clean of mortar, grout, and dirt.
3. Test samples of adjacent non-masonry materials that cannot be protected for a possible reaction with the cleaning materials.
4. Test procedures will include the evaluation of materials and the techniques proposed for cleaning procedures.
5. Obtain the ENGINEER's approval of sample cleaning before proceeding with the cleaning of masonry.

F. Clean exposed unglazed masonry on which no green efflorescence appears. Clean exposed masonry surfaces after mortar and grout is fully cured and in accordance with BIA’s Technical Notes on Brick Construction 20.

G. Pre-Wetting and Rinsing:
1. Thoroughly pre-wet surfaces with clean water prior to the application of cleaners to limit the activity of the cleaning solution to the masonry surface and to prevent the cleaning solution from being absorbed too readily. Do not saturate.
2. Use spray equipment for pre-wetting and rinsing procedures using 400 psi to 800 psi and a flow rate of 4 gpm to 6 gpm. Flow down the wall using a flared nozzle. The high-pressure application of cleaning materials is not permitted.

H. Cleaning Process:
1. Remove excess mortar deposits with wooden scrapers or other nonmetallic scraping devices.
2. Thoroughly pre-wet a large area of the masonry surface to be cleaned. Do not saturate.
3. Using a densely packed soft-fibered masonry washing brush or low-pressure spray, 50 psi maximum, apply the diluted cleaning solution freely.
4. Allow the cleaning solution to stay on the wall for 1 minute to 3 minutes depending upon drying conditions. Do not allow the cleaning solution to dry.
5. Scrape off excess mortar deposits and reapply the cleaning solution.
6. Rinse treated surfaces thoroughly with clean water, flowing downward. Remove cleaning compounds, dirt, etc.
7. Reapply as necessary.

END OF SECTION

INTENTIONALLY BLANK

SECTION 04 22 00
CONCRETE MASONRY UNIT

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for concrete masonry units.
- B. Related Sections:
  1. SECTION 05 50 00 – METAL FABRICATIONS
  2. SECTION 07 19 00 – WATER REPELLENTS
  3. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  3. A 951 – Standard Specification for Steel Wire for Masonry Joint Reinforcement
  4. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
  5. A 1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  6. C 90 – Standard Specification for Hollow Loadbearing Concrete Masonry Units
  7. C 144 – Standard Specification for Aggregate for Masonry Mortar
  8. C 150 – Standard Specification for Portland Cement
  9. C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by means of the Guarded-Hot-Plate Apparatus
  10. C 207 – Standard Specification for Hydrated Lime for Masonry Purposes
  11. C 270 – Standard Specification for Mortar for Unit Masonry
  12. C 404 – Standard Specification for Aggregates for Masonry Grout
  13. C 476 – Standard Specification for Grout for Masonry
  14. C 1019 – Standard Test Method for Sampling and Testing Grout for Masonry
  15. C 1072 – Standard Test Methods for Measurement of Masonry Flexural Bond Strength
  16. C 1314 – Standard Test Method for Compressive Strength of Masonry Prisms
  17. C 1384 – Standard Specification for Admixtures for Masonry Mortars
  18. D 2000 – Standard Classification System for Rubber Products in Automotive Applications
  19. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  20. E 514 – Standard Test Method for Water Penetration and Leakage Through Masonry
- B. International Code Council (ICC):
  1. International Building Code (IBC), Chapter 21, Section 2105 – Quality Assurance
- C. National Concrete Masonry Association (NCMA):
  1. TEK 3-1C – All-Weather Concrete Masonry Construction

1.3 PRE-INSTALLATION MEETINGS:
- A. Convene at the site 4 weeks prior to beginning the Work of this Section.
- B. Attendance: OWNER, ENGINEER, CONTRACTOR, Structural Engineer, Masonry Subcontractor, Masonry Subcontractor's Cleaning Installer, and related trades.
- C. Review and discuss: Contract Documents, site conditions, scheduling, and other matters affecting the application.
- D. Schedule the meeting after the review and approval of submittals for the Work of this Section but prior to the erection of the mockup.
- E. Provide meeting minutes.

1.4 SUBMITTALS
- A. Product Data: Information on reinforcing and anchors including sizes, profiles, materials, and finishes.
- B. Samples:
  1. CMU in quantities showing the full color and texture range: Two.
  2. Colored mortar: 1/2 inch by 1/2 inch by 3 inches long colored mortar.
- C. Quality Control Submittals:
  1. CMU: Certificates of compliance with specifications for masonry unit grades, types, and classes.
  2. Mortar: Proposed design mortar mixes for each type of mortar, and test reports indicating mortar compliance in accordance with ASTM C 270.
  3. Grout: Mix designs for grout for masonry reinforcement. Submit test reports for grout materials in accordance with ASTM C 476 from an independent testing laboratory certifying conformance to the grout strength requirements.
  4. Integral water repellent:
     a. A certification report indicating the CMU Manufacturer is certified by the Water Repellent CMU Admixture Manufacturer.
     b. Test reports prepared by a qualified independent laboratory indicating compliance with the specified performance requirements for integral CMU and mortar water repellency.
  5. Core insulation: Certificates of compliance from an independent testing laboratory that core insulation meets fire hazard classification requirements.

D. Warranty Documentation:
   1. Sample warranty.
   2. Installation warranty.
   3. Warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: The CMU Manufacturer shall be certified by the Integral CMU Water Repellent Admixture Manufacturer through testing of CMU produced by the CMU Manufacturer using the water repellent Manufacturer's standard spray bar test and the applicable ASTM test methods.
   1. A portion of the specified CMU shall be tested by the Integral CMU Water Repellent Admixture Manufacturer within 2 days of CMU production for water repellency and for compliance with specified performance requirements.
   2. Submit evidence and results of testing to the ENGINEER.

B. Installer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

C. Masonry Units: In accordance with NCMA TEK 3-1C, and ASTM C 90 for masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances.

D. Testing and Inspection: The ENGINEER will provide independent field inspection and testing of masonry Work in accordance with ICC IBC Chapter 21, Section 2105. The independent inspector will be present and will inspect the Work during the preparation of masonry wall prisms, sampling, the placing of hollow block units, the placement of reinforcement, and immediately prior to and during grouting of masonry on the Work.
   1. Masonry units: Inspect masonry units prior to and during installation for compliance with the specified requirements.
   2. Masonry assemblies:
      a. Determine the F'm by the prism method, in accordance with ASTM C 1314.
         1) Provide a set of five prisms made and tested prior to the start of construction for each masonry material.
         2) During construction, provide one set of three prisms for each 5,000 sf of masonry wall.
         3) Minimum compressive strength at 28 days: 2,000 psi.
      b. Verify the dimensions and the condition of grout spaces and the type, quantity, and placement of reinforcement during installation and just prior to the closing of cleanouts.
      c. Verify the type, quantity, and installation of reinforcement, anchors, and ties.
      d. Inspect the placement of grout:
         1) Verify grout spaces are clear and ready to receive grout.
         2) Verify grout is properly consolidated and then reconsolidated after 15 minutes using mechanical vibrators.
      e. Inspect the installation of mortar: Verify head and bed joints are installed as specified in this Section.

E. Grout: Mold and test one set of compressive strength cubes in accordance with ASTM C 1019 for each 5,000 sf of masonry wall area or fraction thereof.

F. Water repellent CMU and mortar for wall construction shall comply with the following performance requirements:
   1. Water permeance of masonry: In accordance with ASTM E 514 capable of achieving a Class E rating.
   2. Flexural bond strength of masonry: In accordance with ASTM C 1072; no statistically lower masonry flexural bond strength as a result of adding integral water repellent CMU and mortar admixtures when compared to a control (containing no admixtures) CMU and mortar.
   3. Water repellent mortar admixture classification: Capable of meeting all the requirements for a water repellent classification when tested in accordance with ASTM C 1384.
   4. F'm prisms: In accordance with ASTM C 1314; no statistically lower compressive strength of prisms as a result of adding integral water repellent CMU and mortar admixtures when compared to a control, containing no admixtures, CMU and mortar.

G. Mockup:
   1. Size: 6 feet high by 8 feet wide, with one 90 degree corner, a 2 foot wide return wall, and one finished opening.
   2. Show:
      a. Masonry color and texture range.
      b. Mortar joint size, color, and profile.
      c. Each bond pattern.
      d. Reinforcing.
      e. Flashings and weeps.
      f. Masonry control joint.
   3. Demonstrate:
      a. The ability to keep insulation and grout isolated and in certain cells in any sequence of placement.
      b. Materials shall be restricted to cells and bond beams intended to receive each material.
      c. Construction within the required tolerances for wall plumb, joint construction, and bond pattern.
   4. Locate with the primary orientation facing south.
   5. Allow 7 to 14 days after panel erection for mortar to fully cure prior to review by the ENGINEER.
   6. Clean the panel within the specified time requirements for cleaning prior to review by the ENGINEER.
   7. The approved mockup shall indicate the quality of, and will be the basis for acceptance of, the permanent masonry construction. Leave the mockup in place until masonry Work is complete and accepted by the ENGINEER to ensure minimum deviation from the sample panel.
   8. After review and acceptance by the ENGINEER, apply water repellent as specified in SECTION 07 19 00 to establish coverage rates and warranty.
   9. The approved mockup shall not remain as part of the Work.

H. Efflorescence: Protect masonry construction to prevent efflorescence. Take necessary measures to eliminate moisture from entering incomplete walls that have not received parapet copings or water repellents. Remove efflorescence prior to applying water repellents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry off the ground; prevent contact with materials that could cause staining or damage.
B. Protect reinforcement and anchors from corrosion.
C. Deliver cement and lime in the Manufacturer's original, unopened packages or containers.
D. Protect materials from moisture absorption and damage; reject damaged containers.
E. Store aggregate to prevent the inclusion of foreign matter.

1.7 SITE CONDITIONS

A. Load Application:
   1. Do not apply uniform loads for at least 12 hours after completing masonry columns or walls.
   2. Do not apply concentrated loads for at least 3 days after completing masonry columns or walls.
B. Environmental Requirements – General: In accordance with NCMA TEK 3-1C for hot and cold weather construction.
C. Hot Weather Requirements: If ambient temperature is over 95°F or relative humidity is less than 50%, protect from direct sun and wind exposure for a minimum of 2 days after installation.
D. Cold Weather Preparation:
   1. Remove ice and snow that has formed on top of the foundation wall or the base construction upon which masonry will set.
   2. Apply heat until the top surface is dry to the touch. Do not build on frozen Work.

1.8 WARRANTY

A. Manufacturer:
   1. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the CMU system and associated appurtenances.
   2. The integral CMU and Mortar Water Repellent Admixture Manufacturer shall warrant that admixture is free of defects and meets the Manufacturer’s published physical and chemical properties.
   3. The CMU Manufacturer shall warrant that integral CMU water repellent admixture has been provided at the appropriate dosage rate in CMU units transported to the site for use in exterior wall construction.
B. Installer: The Masonry Installer shall warrant that only CMU and mortar containing the water repellent admixture have been installed in exterior walls.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. CMU:
   1. Basalite Concrete Products, LLC
   2. Colorado Best Block
   3. Echelon Trenwyth Industries
   4. Featherlite Building Products
B. Colorant:
   1. Solomon Colors, Inc.
C. Masonry Accessories:
   1. Heckmann Building Products, Inc.
   2. Hohmann and Barnard, Inc.
D. Cement:
   1. Lehigh Hanson
   2. Martin Marietta Materials, Inc.
E. Lime:
   1. Carmeuse Lime and Stone
   2. Graymont Limited
   3. Lhoist North America
F. Preblended Mortars and Grouts:
   1. The Quikrete Companies
   2. US Mix Company
G. Mortar Colorants:
   1. Davis Colors
   2. Lanxess Corporation
   3. Solomon Colors, Inc.
H. Integral Water Repellent:
   1. ACM Chemistries, Inc., Rainbloc
   2. The Euclid Chemical Company, Hydrapel
I. Foamed-In-Place Masonry Core Insulation – Standard:
   1. Tailored Chemical Products, Inc., Core-Fill 500 Foam Insulation
J. Veneer Wall Ties for Concrete Cavity Wall Backup:
   1. Heckmann Building Products, Inc., No. 75 Pos-I-Tie System
   2. Hohmann and Barnard Inc., Thermal Concrete 2-Seal Tie
K. Veneer Wall Ties for Masonry Cavity Wall Backup:
   1. Heckmann Building Products, Inc., Ladder Pintle Eye Wall 1300
   2. Hohmann and Barnard, Inc., 170 M-L Truss Adjustable Eye-Wire Joint Reinforcement

L. Veneer Wall Ties at Metal or Wood Stud Walls with Sheathing and Cavity Insulation:
   1. Heckmann Building Products, Inc., Pos-I-Tie System
   2. Hohmann and Barnard, Inc., 2-Seal Tie
M. Dovetail Anchors for Concrete, Masonry, and Metal or Wood Stud Walls with Sheathing and no Cavity Insulation:
   1. Heckmann Building Products, Inc., 315-c/316
   2. Hohmann and Barnard, Inc., DW-10/Vee Byna Tie
N. Copper Flashings:
   1. Hohmann and Barnard, Inc., H&B C-Coat flashing
O. Single and Double Wythe Joint Reinforcement:
   1. Heckmann Building Products, Inc.
   2. Hohmann & Bernard, Inc.
P. Rubberized Asphalt Flashing:
   1. GCP Applied Technologies, Perm-A-Barrier
   2. Wire-Bond, Aquaflash 500
Q. Weeps:
   1. Mortar Net, Weep Vents
R. Grout Screen:
   1. Hohmann and Barnard, Inc., MGS Mortar/Grout Screen
   2. MasonPro, Grout Stop
S. Mortar Dropping Control:
   1. MortarNet
T. Preformed Control Joint:
   1. Hohmann and Barnard, Inc., RS Series
   2. Wire-Bond, Rubber Control Joint
U. Reinforcing Bar Positioners:
   1. Hohmann and Barnard, Inc., RB Rebar Positioner
V. Cleaner:
   1. ProSoCo, Sure-Klean Custom Masonry Cleaner

2.2 MATERIALS

A. CMU:
   1. In accordance with ASTM C 90, Type I, moisture controlled.
   2. Provide normal weight density, (density greater than or equal to 125 pcf).
   3. Provide a minimum CMU 28 day compressive strength, F'm, as shown on the Drawings.
   4. Provide standard units with face dimensions of 16 inches long by 8 inches high nominal. Provide block thickness as shown on the Drawings.
   5. Provide special shapes shown on the Drawings.
B. Mortar and Grout:
   1. Portland cement:
      a. In accordance with ASTM C 150, Type I.
      b. For exposed surfaces, provide cement from one source throughout the Work.
   2. Aggregate:
      a. Mortar: Standard masonry type, in accordance with ASTM C 144.
      b. Grout: In accordance with ASTM C 404.
      c. For exposed surfaces, provide aggregate from one source throughout the Work.
   3. Lime: In accordance with ASTM C 207, Type S.
   4. Colorant: Pure mineral oxide type; color to be selected from the Manufacturer's full color range.
   5. Integral water repellent: Silicate or acrylic admixture.
   6. Water: Clean and free from oils, acids, alkalis, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.
C. Mortar Type:
   1. Mortar shall be Type M or Type S in accordance with ASTM C 270.
   2. Mortar placed below grade shall be Type M.
D. Grout:
   1. Grout Mix:
      a. Fine and coarse grout, in accordance with ASTM C 476.
      b. Compressive strength: Minimum 2,000 psi at 28 days.
      c. Slump: 9 inches, ±1 inch.
   2. Mixing:
      a. Mix grout in accordance with ASTM C 476.
      b. Thoroughly mix ingredients in the quantities needed for immediate use.
      c. Mix dry ingredients mechanically until uniformly distributed; add water to achieve a workable consistency.
      d. Use grout within 2 1/2 hours after initial mixing at ambient temperatures below 80°F and within 1 1/2 hours after initial mixing at ambient temperatures over 80°F.
      e. Do not add accelerators, retarders, water repellents, antifreeze compounds, or other additives without the ENGINEER's approval.

E. Masonry Core Insulation:
   1. Foamed-in-place insulation – standard:
      a. An amino-plast foam two-component thermal insulation of plastic resin and catalyst foaming agent surfactant.
      b. Surface burning characteristics: Maximum flame spread, smoke developed, and fuel contributed of 0, 5, and 0, respectively, when tested in accordance with ASTM E 84.
      c. Combustion characteristics: Shall be noncombustible, Class A building material.
      d. Thermal values: R-value of 4.91 per inch at 32ºF mean; in accordance with ASTM C 177.
   2. Loose fill insulation, EPS insulation core inserts, or other types of insulation.

2.3 ACCESSORIES

A. Single Wythe Joint Reinforcement:
   1. Ladder type, hot-dip galvanized steel wire in accordance with ASTM A 951, 9 gauge side rods with 9 gauge cross ties.
   2. Width: Nominal wall thickness less 2 inches.
   3. Corner and tee fittings: The type to match reinforcement.
   4. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

B. Double Wythe Joint Reinforcement:
   1. Ladder type, galvanized steel wire in accordance with ASTM A 951, 9 gauge side rods with 9 gauge cross ties.
   2. Width: Nominal wall thickness less 2 inches.
   3. Corner and tee fittings: Type to match reinforcement.
   4. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.

C. Veneer Wall Ties for Concrete Cavity Wall Backup:
   1. Tapcon screw with 3/16 inch diameter triangle wire tie, in accordance with ASTM A 1064, of length required to provide minimum 2 inch embedment into mortar and no closer than 3/4 inch to face of exposed masonry; barrel consists of one-piece screw, washer, flanged head and eye to receive wire tie and is designed to seat directly on structural backup, with flanged head covering fastener hole.
   2. Barrel shaft length to suit conditions.
   3. Finish:
      a. Wire tie: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.
      b. Barrel material: 92% Zamac 2 zinc.

D. Veneer Wall Ties for Masonry Cavity Wall Backup:
   1. Truss type, galvanized steel wire, in accordance with ASTM A 951, 9 gauge side and cross rods, and 3/16 inch pintle rods and eyes in accordance with ASTM A 1064.
   2. Corner and tee fittings: Type to match reinforcement.
   3. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.

E. Veneer Wall Ties at Metal or Wood Stud Walls with Sheathing and Cavity Insulation:
   1. Self-drilling screw with 3/16 inch diameter triangle wire tie, in accordance with ASTM A 1064, of length required to provide minimum 2 inch embedment into mortar and no closer than 3/4 inch to face of exposed masonry; barrel consists of one-piece screw, washer, flanged head and eye to receive wire tie and is designed to seat directly on cavity insulation, with flanged head covering fastener hole.
   2. Barrel shaft length to accommodate sheathing and insulation thickness.
   3. Finish:
      a. Wire tie: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153, Class B-2.
      b. Barrel material: 92% Zamac 2 zinc.

F. Dovetail Anchors for Concrete, Masonry, and Metal or Wood Stud Walls with Sheathing and no Cavity Insulation:
   1. Dovetail-shaped wire tie, 3/16 inch, in accordance with ASTM A 1064 with 12 gauge steel anchor plate in accordance with ASTM A 1008 accommodating vertical height adjustment of wire tie.
   2. Coating: Hot-dipped 1.5 ounce zinc coating, in accordance with ASTM A 153 Class B-2.

G. Reinforcing Bars: Deformed carbon steel, in accordance with ASTM A 615, Grade 60.

H. Copper Flashings: A 5 ounce electrolytic copper sheet uniformly coated on both sides with acid-proof alkali-proof elastic bituminous compound, factory-applied, weighing no less than 6 ounces psf.

I. Rubberized Asphalt Flashing: Cold-applied self-adhesive membrane consisting of an 8 mil thickness high density cross-laminated PE film integrally bonded to a 32 mil thickness rubberized asphalt, with a removable release liner.

J. Weeps:
   1. High-density PP, nylon, and recycled polyester material in a 90% open mesh weave fabric.
   2. Size: 2 1/4 inches by 3 1/2 inches by 1/2 inch.
   3. Color: To be selected from the Manufacturer's standards.
   4. Spacing: 24 inches on center unless shown on the Drawings.

K. Grout Screen: Monofilament PP mesh screen.

L. Mortar Dropping Control:
   1. High-density PP, nylon, and recycled polyester material in a 90% open mesh weave fabric.
   2. Size: 1 inch wide or 2 inches wide to fit cavity 10 inches high by 60 inches long.

M. Joint Sealants: As specified in SECTION 07 92 00.

N. Preformed Control Joint: Flexible rubber compound, black color, in accordance with ASTM D 2000.

O. Reinforcing Bar Positioners:
   1. Steel wire, 9 gauge in accordance with ASTM A 1064.
   2. Coating: Hot-dipped 1.5 ounce zinc coating in accordance with ASTM A 153 Class B-2.

P. Loose Steel Lintels: As specified in SECTION 05 50 00.

Q. Cleaner: The type suited to the surfaces and conditions and recommended by the Masonry Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Cover the wall cavity and the masonry unit cores when Work is not in progress to keep water from entering the wall cavity or the cores. Provide sufficient ballast to keep the cover in place.
B. Pull back scaffold planks next to the wall to avoid splash on the wall. Tip planks daily to remove excess mortar and dirt.
C. Remove mortar droppings before they harden. After the mortar sets, the wall shall be brushed daily.
D. Prevent grout or mortar from staining the face of masonry to be left exposed. If grout or mortar contacts the face of such masonry, remove it immediately.

3.2 INSTALLATION

A. Establish lines, levels, and courses shown on the Drawings. Protect from displacement.
B. Maintain masonry courses to uniform dimensions. Form horizontal and vertical joints of uniform thickness.
C. Lay masonry plumb and level. Do not adjust masonry units after mortar has set.
D. Lay solid masonry units in full mortar bed, with full head joints. Lay hollow masonry units with face shell bedding on the head and bed joints.
E. Closures shall be rocked into place with the head joint mortar thrown against the two adjacent units in place.
F. Do not butter corners or furrow joints.
G. Keep the cavity or air space and the face of masonry free of mortar droppings.
H. Machine cut masonry with straight cuts and clean edges; prevent oversized or undersized joints. Discard damaged units. Do not expose cut cells.
I. Isolate masonry from structural members with compressible filler.
J. When joining fresh masonry to partially set masonry, remove loose masonry and mortar; clean and lightly wet the exposed surface of set masonry.
K. Stop horizontal runs by racking back the normal bond unit in each course. Toothing is not permitted.
L. Fully grout steel door frames set into the masonry as the wall is being built.
M. Horizontal Reinforcement:
    1. Place reinforcement at a maximum of 16 inches on center vertically, at the topmost course, and at the first two courses above and below openings.
    2. Extend a minimum of 24 inches each side of openings.
    3. Center reinforcing in the wall.
    4. Lap ends 6 inches at a minimum; use fabricated tee and corner fittings at corners and intersections.
N. Secure masonry to structural members with strap anchors spaced a maximum of 16 inches on center.
O. Control Joints:
    1. Do not continue horizontal joint reinforcement through control joints.
    2. Keep joints free from mortar and grout.
    3. Install preformed control joint material.
    4. Install joint backing and joint sealant at control joints as specified in SECTION 07 92 00.
    5. Form expansion joint as shown on the Drawings.
P. Finishing Mortar Joints:
    1. Exposed locations: Tool joints to a concave profile.
    2. Concealed locations: Strike joints flush.
    3. In general, use steel jointers. However, SST jointers shall be used where white or a light colored mortar is used.
    4. The use of a 16 inch or longer sled runner is required at horizontal joints.
    5. Fill joints in masonry work with mortar as each course is laid.
    6. Fill bed and head joints solidly with mortar. The thickness of mortar joints shall be uniform and true to dimensions.
Q. Reinforcing Bars:
    1. Position reinforcing accurately and hold securely in place to prevent displacement. Maintain a minimum 1 inch space between masonry and reinforcing.
    2. Grout lifts shall not exceed 6 times the width of the grout space, with a maximum of 48 inches high.
    3. Vibrate grout during and after placement to ensure complete filling.
    4. Stop grout 1 1/2 inches below the top of masonry if grouting is stopped for 1 hour or more, except where completing the grouting of a finished wall.
R. Flashings:
    1. Install flashing with the outer edge flush with the outside face of masonry; extend up substrate 8 inches at a minimum.
    2. Provide flashing in lengths as long as practicable.
    3. Lap end joints 4 inches at a minimum and seal.
    4. Form end dams where flashing is stopped or interrupted.
S. Weeps:
    1. Locate weeps in head joints in the first course above flashings at a maximum of 24 inches on center.
    2. Set weeps flush with the exterior face of masonry.
T. Install mortar dropping control continuously in cavities above flashings.
U. Foamed-In-Place Insulation – Standard:
    1. Install foamed-in-place insulation from the interior, prior to the installation of interior finish work, in accordance with the Manufacturer's instructions.
    2. Fill open cells and voids in exterior hollow concrete masonry walls and where shown on the Drawings.

3. At walls receiving interior wall finishes, pump the foam through a horizontal row of 5/8 inch holes that are drilled into the mortar joints every 8 inches on center at an approximate height of 5 feet from the finished floor level around the entire wall. Repeat this method at an approximate height of 10 feet above the first horizontal row of holes if the insulated wall height is higher than 16 feet above the finished floor level. Patch holes and retool course.
4. At exposed CMU walls receiving no covering finish, pump the foam into the top of the open cell of the CMU wall at intervals recommended by the Manufacturer. Repeat this method as the wall is constructed. Fill open cells that are below windowsills.

V. Loose Fill Insulation, EPS Insulation Core Inserts, or Other Types of Insulation: As shown on the Drawings.

W. Installation Tolerances (maximum variation from):
1. Alignment of columns and pilasters: ±1/4 inch.
2. Alignment face to face of adjacent units: ±1/8 inch.
3. Vertical alignment of head joints: ±1/2 inch in 10 feet.
4. True plane of wall: ±1/4 inch in 10 feet and 3/8 inch in 20 feet or more.
5. Plumb: ±1/4 inch in 10 feet noncumulative and 1/4 inch in 20 feet or more.
6. Level coursing: ±1/8 inch in 3 feet; 1/4 inch in 10 feet; 1/2 inch in 30 feet.
7. Variation of the linear building line from its established position in the plan: Shall not exceed 1/2 inch in any bay or 20 foot maximum, nor shall it exceed 3/4 inch in 40 feet or more.
8. Joint thickness: ±1/8 inch.
9. Cross-sectional thickness of walls: ±1/4 inch.

X. Cold Weather Requirements:
1. Implement cold weather construction procedures when ambient temperature or the temperature of masonry units falls below 40°F.
2. When ambient temperature is between 25°F and 20°F, use heat sources on both sides of the masonry under construction. Install wind breaks when the wind velocity is in excess of 15 mph.
3. When ambient temperature is below 20°F, provide an enclosure for the masonry under construction and use heat sources to maintain temperatures above 32°F within the enclosure.
4. When the mean daily temperature is between 40°F and 25°F, protect completed masonry from rain or snow by covering it with a weather resistive membrane for 1 day after construction.
5. When the mean daily temperature is between 25°F and 20°F, completely cover completed masonry with insulating blankets, or equal protection, for 1 day after construction.
6. When mean daily temperature is below 20°F, maintain the masonry temperature above 32°F for 1 day after construction by enclosure with supplementary heat.
7. Remove and replace Work that has been frozen or damaged by freezing conditions.
8. Failure to follow cold weather procedures will be construed as evidence that masonry has frozen. Such masonry shall be removed and replaced.

Y. Cold Weather Mortar and Grouting Requirements:
1. The temperature of masonry to be grouted shall be greater than 35°F when grout is placed. Place grout in masonry at a minimum temperature of 70°F and at a maximum temperature of 120°F. Maintain grouted masonry above 35°F for 1 day following the placement of grout.
2. Heat sand and mixing water when the air temperature is below 40°F in order to provide mortar and grout temperatures between 40°F and 120°F when used.
3. Do not heat sand or water above 120°F.

3.3 PROTECTION:

A. Wall:
1. During erection, cover the tops of partially completed walls with a strong waterproof membrane at the end of each day or Work stoppage.
2. Extend the cover a minimum of 24 inches down both sides and hold securely in place.

3.4 CLEANING

A. General: Monitor, log progress of completion, and schedule cleaning of exterior masonry walls in accordance with the following:
1. The cleaning process for completed exterior masonry walls shall occur a minimum of 7 days and a maximum of 14 days after the erection of the wall.
2. Schedule cleaning operations to coincide within the stated period. Include multiple operations at time junctures as required.

B. Preparation:
1. Point holes in exposed masonry and cut out and repoint defective joints.
2. Remove efflorescence using the appropriate specified cleaner, but in a very diluted mixture. Consult the cleaner Manufacturer for appropriate dilution rates.

C. Protection: Provide coverings and masking to protect plant materials and other non-masonry surfaces from damage.

D. Environmental Conditions:
1. Ambient and substrate temperatures shall be above 40°F to proceed with cleaning operations. If ambient and substrate temperatures are below 40°F, heat the water to a minimum of 120°F and a maximum of 200°F to achieve acceptable environmental conditions.
2. Conduct cleaning operations at a time when the masonry surfaces will have adequate time to thoroughly dry without freezing.

E. Test:
   1. Test cleaning methods on a sample wall panel or portion of the building wall as directed. The test area shall be located in an unobtrusive area.
   2. The fundamental consideration for cleaning procedures is to ensure there is no damage to the masonry substrates while achieving a wall that is clean of mortar, grout, and dirt.
   3. Test samples of adjacent non-masonry materials that cannot be protected for a possible reaction with the cleaning materials.
   4. Test procedures will include the evaluation of materials and the techniques proposed for cleaning procedures.
   5. Obtain the ENGINEER's approval of sample cleaning before proceeding with the cleaning of masonry.

F. Clean exposed unglazed masonry on which no green efflorescence appears. Clean exposed masonry surfaces after mortar and grout is fully cured.

G. Pre-Wetting and Rinsing:
   1. Thoroughly pre-wet surfaces with clean water prior to the application of cleaners to limit the activity of the cleaning solution to the masonry surface and to prevent the cleaning solution from being absorbed too readily. Do not saturate.
   2. Use spray equipment for pre-wetting and rinsing procedures using 400 psi to 800 psi and a flow rate of 4 gpm to 6 gpm. Flow down the wall using a flared nozzle. The high-pressure application of cleaning materials is not permitted.

H. Cleaning Process:
   1. Remove excess mortar deposits with wooden scrapers or other nonmetallic scraping devices.
   2. Thoroughly pre-wet a large area of the masonry surface to be cleaned. Do not saturate.
   3. Using a densely packed soft-fibered masonry washing brush or low-pressure spray, 50 psi maximum, apply the diluted cleaning solution freely.
   4. Allow the cleaning solution to stay on the wall for 1 to 3 minutes depending upon drying conditions. Do not allow the cleaning solution to dry.
   5. Scrape off excess mortar deposits and reapply the cleaning solution.
   6. Rinse treated surfaces thoroughly with clean water, flowing downward. Remove cleaning compounds, dirt, etc.
   7. Reapply as necessary.

END OF SECTION

SECTION 04 23 00
GLASS MASONRY UNIT

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for glass masonry units.
- B. Related Sections:
  1. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. C 144 – Standard Specification for Aggregate for Masonry Mortar
  3. C 150 – Standard Specification for Portland Cement
  4. C 207 – Standard Specification for Hydrated Lime for Masonry Purposes
  5. C 270 – Standard Specification for Mortar for Unit Masonry
- B. National Fire Protection Association (NFPA):
  1. 257 – Standard on Fire Test for Window and Glass Block Assemblies
- C. The Masonry Society (TMS):
  1. 402 – Building Code Requirements for Masonry Structures
  2. 602 – Specification for Masonry Structures

1.3 SUBMITTALS
- A. Product Data: Information on reinforcing and anchors including sizes, profiles, materials, and finishes.
- B. Samples: Two glass masonry unit samples in each pattern.
- C. Quality Control Submittal:
  1. Glass masonry test reports: Indicating glass masonry units are classified for the specified fire protection rating in accordance with NFPA 257.
  2. Mortar mix: Submit the proposed design mortar mix, and test reports indicating mortar compliance in accordance with ASTM C 270.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Mockup:
  1. Size: 4 feet by 4 feet, minimum.
  2. Show:
     a. Masonry units, reinforcing, and anchors.
     b. Mortar joint size, color, and profile.
  3. Locate where directed by the ENGINEER.
  4. The approved mockup shall not remain as part of the Work.
- C. Perform Work in accordance with TMS 402 and TMS 602.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store unopened cartons of glass block in a clean, cool, dry area.
- B. Protect reinforcement from weather.

1.6 SITE CONDITIONS
- A. Environmental Requirements:
  1. Hot weather requirements: If the ambient temperature is greater than 95°F or the relative humidity is less than 50%, protect from direct sun and wind exposure for a minimum of 2 days after installation.
  2. Cold weather requirements:
     a. Do not use frozen materials or build upon frozen Work.
     b. Do not install masonry when temperature is 40°F and falling.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Glass Masonry Unit:
  1. Seves Glass Block
  2. Weck Glass Block/Glashaus, Inc.
- B. Glass Masonry Accessories:
  1. Heckmann Building Products, Inc.
  2. Hohmann and Barnard, Inc.
  3. Weck Glass Block/Glashaus, Inc.
- C. Integral Water Repellent:
  1. ACM Chemistries, RainBloc
  2. The Euclid Chemical Company, Hydrapel
- D. External Waterproof Additive – Exterior Applications:
  1. BASF Building Systems, Master Builders, MasterProtect H 400, Water-Based Silane Sealer
- E. Colorant:
  1. Davis Colors
  2. Solomon Colors, Inc.
- F. Asphalt Emulsion:
  1. Karnak Corporation, Karnak 100

2.2 MATERIALS

A. Glass Block:
   1. Size: Nominally 8 inches by 8 inches by 4 inches thick.
   2. Color: Clear.
   3. Pattern: Weck Nubio.

B. Mortar Materials:
   1. Portland cement:
      a. In accordance with ASTM C 150, Type I.
      b. For exposed surfaces, provide cement from one source throughout the Work.
   2. Aggregate:
      a. Sand: Not less than 100% passing a No. 8 sieve, in accordance with ASTM C 144.
      b. For exposed surfaces, provide aggregate from one source throughout the Work.
   3. Lime: In accordance with ASTM C 207, Type S.
   4. Integral water repellent: Silicate or acrylic admixture.
   5. Water: Clean and free from oils, acids, alkalis, organic matter, and other substances in amounts deleterious to mortar or metals in masonry.
   6. Colorant: Pure mineral oxide type; color to be selected from the Manufacturer's full color range.

C. Mortar:
   1. Provide site-mixed lime, portland cement, sand, and color mix when the color is specified.
   2. Design criteria: 1,800 psi minimum, in accordance with ASTM C 270, Type S.
   3. Jobsite mixing of mortar:
      a. Mix using a mechanical mixer. Hand mixing is not permitted.
      b. Mix approximately 3/4 of the required water, all of the cement and lime, and half of the aggregate for a minimum of 2 minutes.
   4. Add the remainder of the water and aggregate; mix for a minimum of 3 minutes.

2.3 ACCESSORIES

A. Panel Reinforcing: Two parallel 9 gauge wires, 2 inches on center with electrically welded cross wires at regular intervals, hot-dip galvanized.

B. Panel Anchors: 20 gauge perforated steel strips, 1 3/4 inches wide by 24 inches long, hot-dip galvanized, finish in accordance with ASTM A 153.

C. Fasteners: Galvanized, with a minimum 3/4 inch of penetration into substrate.

D. Expansion Strips: The Manufacturer's standard PE foam, 3/8 inch thick.

E. Water-Based Asphalt Emulsion.

F. Sealant and Backing: As specified in SECTION 07 92 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that supports are provided at the head and jambs to provide panel support within the opening.

B. Mix mortar components to a consistency that is drier than the mortar used for ordinary masonry. Retempering the mortar after it has taken its initial set is not permitted. Do not use antifreeze compounds or accelerators.

3.2 INSTALLATION

A. Establish lines, levels, and courses as shown on the Drawings. Protect from displacement.

B. Maintain masonry courses to uniform dimensions. Form horizontal and vertical joints of uniform thickness.

C. Lay units in stack bond. Course one unit and one mortar joint to equal 8 inches.

D. Cover sills with a heavy coat of asphalt emulsion. Allow the emulsion to dry for at least 2 hours before placing mortar.

E. Adhere expansion strips to the head and jambs with spot applications of asphalt emulsion. Extend expansion joints completely to the sill.

F. Lay masonry plumb and level. Do not adjust masonry units after the mortar has set.

G. Lay masonry units in full mortar bed, with full head joints.

H. Do not butter corners or furrow joints.

I. Isolate masonry from structural members with a compressible filler.

J. Panel Reinforcing:
   1. Place reinforcing at a maximum of 16 inches on center vertically and in joints immediately above and below openings within panels.
   2. Lap ends 6 inches at a minimum.
   3. Do not bridge expansion joints with reinforcing.
   4. Installation of reinforcing:
      a. Place the lower half of mortar in bed joint. Do not furrow.
      b. Press panel reinforcing into place.
      c. Cover panel reinforcing with the upper half of the mortar bed and trowel smooth. Do not furrow.

K. Panel Anchors:
   1. Place anchors at the jambs and head at a maximum of 24 inches on center.
   2. Embed the panel anchor 18 inches into the glass block mortar bed, extend 6 inches onto the adjacent masonry wall or steel frame, and secure.
   3. Keep the space at the head of the panel and jambs free of mortar.

L. Tool mortar joints to a concave profile while mortar is still plastic and before the final set. Rake out joints requiring sealant.

M. Remove excess mortar from exposed faces immediately.

N. Installation Tolerances – Maximum Variation from:
   1. Alignment face to face of adjacent units: ±1/8 inch.
   2. Vertical alignment of head joints: ±1/2 inch in 10 feet.
   3. True plane of wall: ±1/4 inch in 10 feet and 1/2 inch in 20 feet or more.
   4. Plumb: ±1/4 inch in 10 feet.
   5. Level coursing: ±1/8 inch in 3 feet; 1/4 inch in 10 feet; 1/2 inch in 30 feet.
   6. Joint thickness: ±1/8 inch.

3.3 PROTECTION:

A. Wall:
   1. During erection, cover the tops of partially completed exterior Work with a strong waterproof membrane at the end of each day or at Work stoppage.
   2. Extend the cover a minimum of 24 inches down both sides and hold securely in place.

3.4 CLEANING

A. Protect adjacent and underlying surfaces.

B. Remove surplus mortar from the faces of the glass block when the joints are tooled while it is still plastic by using a clean, wet sponge or a scrub brush having stiff nonmetal bristles.

C. Do not use harsh cleaners, acids, abrasives, or alkaline materials while cleaning glass block.

D. Accomplish the final cleaning of glass block panels after sealant installation as specified in SECTION 07 92 00. Begin at the top of the panel and wash with generous amounts of clean water. Use a clean, dry, soft cloth to remove water from the glass block surface. Change the cloth frequently to eliminate dried mortar particles and aggregate that could scratch the glass surface finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 05 05 23
WELDING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information and execution for welding.
- B. Related Sections:
  1. SECTION 05 50 00 – METAL FABRICATIONS

1.2 REFERENCES
- A. American Society for Nondestructive Testing (ASNT):
  1. SNT-TC-1A – Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing
- B. American Society of Mechanical Engineers (ASME):
  1. Boiler and Pressure Vessel Code
- C. American Water Works Association (AWWA):
  1. C206 – Field Welding of Steel Water Pipe
- D. American Welding Society (AWS):
  1. D1.1 – Structural Welding Code – Steel
  2. QC1 – Specification for AWS Certification of Welding Inspectors

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Information regarding the location, type, size, and extent of welds.
  2. Distinguish between shop and field welds.
  3. Control joints or groups of joints in which the welding sequence is especially important to minimize shrinkage stresses and distortion.
  4. Specify the groove depths applicable for the effective throat required for the welding process.
  5. Indicate welding positions and the details of the welded joints and the preparation of parent metal that is required to make them.
  6. Joints in accordance with AWS D1.1, Section 3 shall be so noted on the Shop Drawings; joints that do not meet this requirement shall be qualified in accordance with AWS D1.1, Section 4.
  7. Nondestructive testing procedure specifications prepared in accordance with the applicable Welding Code.
- B. Quality Control Submittals:
  1. Welder/welding operator qualifications.
  2. Shop welding inspector credentials.
  3. Shop welding inspector's report.
- C. Submittals required in this Section shall be submitted and approved prior to performing welding operations.
- D. Prequalify welding procedures in accordance with the applicable code:
  1. Submit a Welding Procedure Specification for each weld to be used (field or shop). For each Submittal clearly indicate whether the weld is prequalified under the AWS code.
  2. Use welds which are prequalified in accordance with AWS D1.1, Clause 3.
  3. For special conditions where the CONTRACTOR proposes to use welds which are not prequalified under AWS D1.1, the welds shall be qualified by testing:
     a. Submit a written statement explaining why a prequalified weld cannot be used in the situation.
     b. Submit a Procedure Qualification Record for each weld procedure that is not prequalified, in accordance with AWS D1.1, Clause 4.
     c. Variables noted in the Procedure Qualification Record shall be able to be duplicated and the welder performing the weld shall be qualified to meet the criteria of the submitted weld procedure.
- E. Provide welding procedures for, but not limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plate and ring flange welds, plates for lug connections, and structural welding.

1.4 QUALITY ASSURANCE
- A. Perform welding with skilled welders, welding operators, and tackers who have adequate experience in the methods and materials to be used. Qualify welders, welding operators, and tackers in accordance with the applicable code. Welders performing field welds on pipe shall be qualified in accordance with AWS D1.1 or ASME Boiler and Pressure Vessel Code, Section IX using test position 6G. Qualify welders on positions in which they are welding. Welding completed by welders who are not qualified shall be rejected.
- B. Welding Inspector: AWS certified, in accordance with AWS QC1, with prior inspections experience of welds specified.
- C. Testing Agency: Personnel performing tests shall be NDT Level II Certified in accordance with ASNT SNT-TC-1A.
- D. Qualifications:
  1. Welders, welding operators, and tackers shall be qualified by an independent, local, approved testing agency. Submit evidence of qualification, including proof that each welder, welding operator, and tacker has been continuously engaged in the given process of welding for which the welder, welding operator, or tacker is qualified with no gaps in experience of more than 6 months. Welders, welding operators, and tackers with gaps in experience of more than 6 months, and those whose ability is questioned by the ENGINEER for a specific reason, shall undergo requalification under the provisions of the applicable standard.
  2. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Tests for qualification shall be performed in the presence of the testing agency or in the presence of a certified welding inspector appointed by the testing agency. Furnish material and bear the expense of qualifying welders and furnish copies of certifications to the ENGINEER or designated representative.

3. If radiographic testing is used in lieu of the prescribed AWS bend tests, the weld reinforcements do not need to be ground or otherwise smoothed for inspection unless surface irregularities or the juncture with the base metal would cause objectionable weld discontinuities to be obscured in the radiograph. The test coupon shall be radiographed from the top center line to the bottom center line on either side. Radiographic testing shall follow the procedure in accordance with AWS D1.1. Film and test specimens shall be provided to the ENGINEER.
4. Welders on steel pipe shall be qualified for groove welding in all four positions (flat, overhead, vertical, and horizontal). This qualification can be achieved with a single test or a combination of tests.
5. Welds on pipe less than 24 inches in diameter, welds with groove angles less than 30 degree, or welding performed from one side without backing require their own Welding Procedure Specification and Procedure Qualification Record in accordance with AWS D1.1, Clause 4. The welder also needs to be qualified to perform these procedures in accordance with AWS D1.1, Clause 4.

E. Welding and Nondestructive Testing Requirements:

Welding and Nondestructive Testing						
Specification Section No.	**Governing Welding Codes or Standards**	**Submit Welding Procedure Spec.**	**Submit Welder/ Welding Operator Qualifications**	**On-site Welding Construction Project Inspector Required**	**Submit Written Nondestructive Testing Procedure Specifications**	**Nondestructive Testing Requirements**
05 05 23 05 50 00	AWS D1.1, Structural Welding Code-Steel	Yes	Yes	No	No	100% visual testing of all welds; as specified in this Section

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

A. Site Work: For pipe welding in a trench, excavate the bottom of the trench sufficient to allow for welding and to provide the ENGINEER adequate space to inspect the weld. The bottom of the trench shall not contain standing water.

B. Welders: The ENGINEER will verify that welders on-site have approved Welder Qualification Test Records.

C. Materials:
1. The ENGINEER will verify that filler metals match the Welding Procedure Specification.
2. The ENGINEER will verify that shielding requirements are in accordance with the Welding Procedure Specification.
3. Low hydrogen electrodes (such as E7018) shall be stored in unopened containers or in an oven and shall not exceed a 4 hour to 10 hour exposure time with rebaking in accordance with AWS D1.1.

D. Metal Preparation:
1. Parent metal shall be cleaned of all coating, deposits, or residues and shall be dry.
2. Parent metal shall be preheated as detailed on the Welding Procedure Specification. As a minimum, parent metal shall be preheated to 70°F if the metal surface temperature is below 32°F.

E. Wind Considerations: For flux-cored arc welding, Work shall be sheltered if wind speeds are over 5 mph.

3.2 INSTALLATION

A. Welding:
1. In accordance with the applicable AWS codes.
2. For weld procedures qualified by testing, welding shall be performed in the presence of a certified welding inspector.
3. Complete join penetrations on pipe weld:
   a. Use backing plates for pipe diameters less than or equal to 27 inches.
   b. Use back gouging with back welding for pipe diameters over 27 inches.

B. Weld Completion:
1. Allow weld to cool naturally.
2. Do not spray water or other substances on a hot weld to speed up cooling.
3. The Work schedule shall include time for the weld to cool.

3.3 QUALITY CONTROL

A. ENGINEER Inspection: Field welds shall be visually inspected by the CONTRACTOR in accordance with AWS D1.1, Table 6.1 and logged in the daily report.

B. Non-Destructive Testing by the CONTRACTOR:
1. The CONTRACTOR's certified welding inspector shall perform non-destructive testing of 10% of welded joints, as selected by the OWNER using the following methods:
   a. Single welded lap joints: Either dye penetrant or magnetic particle tested.
   b. Single with seal welded lap joints: Air tested in accordance with AWWA C206.
   c. Field butt joints: Ultrasonic testing of 100% of the joints.
2. Certified welding inspector test results shall be submitted to the ENGINEER.
3. Welds with non-passing test results shall be repaired and retested at the CONTRACTOR's expense.

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for structural steel.
- B. Related Sections:
  1. SECTION 03 62 00 – NON-SHRINK GROUTING
  2. SECTION 05 05 23 – WELDING
  3. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES
- A. American Institute of Steel Construction (AISC):
  1. 303 – Code of Standard Practice for Steel Buildings and Bridges
  2. 360 – Specification for Structural Steel Buildings
  3. Steel Construction Manual
- B. American Welding Society (AWS):
  1. D1.1 – Structural Welding Code – Steel
- C. ASTM International (ASTM):
  1. A 36 – Standard Specification for Carbon Structural Steel
  2. A 53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
  3. A 108 – Standard Specification for Steel Bar, Carbon and Alloy Cold Finished
  4. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  5. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  6. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
  7. A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  8. A 563 – Standard Specification for Carbons and Alloy Steel Nuts
  9. A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
  10. A 992 – Standard Specification for Steel for Structural Shapes
  11. C 109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
  12. E 164 – Standard Practice for Contact Ultrasonic Testing of Weldments
  13. F 436 – Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
  14. F 959 – Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
  15. F 1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength
  16. F 3125 – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- D. The Society for Protective Coatings (SSPC):
  1. SP2 – Hand Tool Cleaning
  2. SP3 – Power Tool Cleaning
  3. Paint 15 – Steel Joist Shop Primer/Metal Building Primer

1.3 SUBMITTALS
- A. Shop Drawings: Indicate profiles, sizes, ASTM grading, spacing, and location of structural members including framed openings, attachments, size and type of fasteners, and connections that are not detailed.
- B. Quality Control Submittals:
  1. Mill certificates.
  2. Certificates of compliance for high-strength bolts.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications:
  1. A minimum of 3 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
  3. For conventionally framed buildings of one to five stories: Certified by AISC's Qualification Program for SBD.
  4. For framed buildings greater than five stories or other complex structures: Certified by AISC's Quality Certification Program for CBD or CBR.
- B. Erector Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section or an AISC Certified Advanced Steel Erector.
  2. Approved by the Manufacturer.
  3. Experienced in erecting structural systems similar in complexity to this Project as evidenced by five completed projects within the previous 3 years.
- C. Welder Qualifications: As specified in SECTION 05 05 23.
- D. Design Requirements: Connections and elements not detailed on the Drawings shall be designed by the CONTRACTOR. Submit Shop Drawings and calculations prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado and in accordance with AISC Manual of Steel Construction.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store steel off the ground on platforms, skids, or other supports; separate with wooden separators.

B. Protect steel from corrosion.
C. Prevent damage to the prime coat; use wooden protectors to prevent damage from chain or cable cinches.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel:
1. Rolled wide flange and WT shapes: In accordance with ASTM A 992.
2. Shapes, bars, and plates: In accordance with ASTM A 36.
3. Hollow structural sections: In accordance with ASTM A 500 1A, Grade B.
4. Pipe: In accordance with ASTM A 53, Grade B.

2.2 ACCESSORIES

A. Anchor Rods: In accordance with ASTM F 1554, Grade 36:
1. Anchor rods shall be headed rod or threaded rod with a heavy hex nut welded to the bottom of the threaded rod.
2. Provide two hexagonal nuts and two hardened steel washers for each anchor rod.
3. Provide 3/8 inch thick square plate washers in lieu of top steel washer on base plates with oversized holes.

B. High-Strength Bolts: Uncoated, in accordance with ASTM F 3125, Type 1.
C. Standard Bolts: In accordance with ASTM A 307, Grade A.
D. Direct Tension Indicators or Load Indicator Washers: The coating type shall match the bolt finish, in accordance with ASTM F 959.
E. Tension-Control Bolts: High-strength, in accordance with ASTM F 3125.
F. Nuts: The type shall match the bolt type and the finish, in accordance with ASTM A 563.
G. Hardened Washers: The type shall match the bolt finish, in accordance with ASTM F 436.
H. Shear Connectors: Forged steel, headed, and unfinished, in accordance with ASTM A 108, Grade 1015, Type B.
I. HCA or Studs: In accordance with ASTM A 108, Grade 1015, Type A or B.
J. Primer Paint: SSPC Paint 15, Type 1, red oxide.
K. Non-shrink Grout: As specified in SECTION 03 62 00, Category II.
L. Welding Materials: The type required for the materials being welded, in accordance with AWS D1.1.

2.3 FABRICATION

A. Fabricate in accordance with AISC 303 and AISC 360.
B. Welding: As specified in SECTION 05 05 23.
C. Where a collection of water inside the structural tubing could occur, provide a drilled drain hole at the lowest point.
D. Cap the open ends of tubes and seal the weld. Wherever practicable, weld connections all around. Seal seams that cannot be welded with joint sealer.
E. Shop Primer Painting:
1. Shop prime steel surfaces except:
a. Surfaces that are to be welded.
b. Contact surfaces of high-strength friction type bolted connections.
c. Surfaces to receive direct-applied fireproofing.
2. Surface preparation: In accordance with SSPC-SP2 or SSPC-SP3.
3. Application: One coat; follow the Coating Manufacturer's instructions.
4. MDFT: 2 mils.
5. Paint primer shall be compatible with finish coating and as specified in SECTION 09 90 00.

F. Galvanizing:
1. Galvanized coating shall be in accordance with ASTM A 123.
2. Galvanize bolts, nuts, and washers in accordance with ASTM A 153 when used to connect steel members that are specified to be galvanized.

PART 3 EXECUTION

3.1 ERECTION

A. Erect structural steel in accordance with AISC 303 and AISC 360.
B. Notify the ENGINEER in writing at least 2 days prior to structural steel fabrication and erection.
C. Accurately assemble to the lines and elevations shown on the Drawings within specified erection tolerances.
D. Align and adjust members forming parts of the complete frame or structure after assembly but before fastening.
E. Provide temporary shoring and bracing members with connections of sufficient strength to resist imposed loads.
F. Provide templates for setting anchor bolts. Position anchor bolts by using templates with two nuts to secure in place prior to the placement of concrete.
G. Align bearing plates with leveling plates.
H. Fasten splices of compression members after abutting surfaces are brought completely into contact.
I. Clean bearing surfaces and surfaces that will be in permanent contact before assembling members.
J. Locate splices only where shown on the Drawings.
K. Tighten erection bolts and leave in place or remove bolts and fill holes with plug welds.
L. Do not correct fabrication by gas cutting unless authorized, in writing, by the ENGINEER.
M. High-Strength Bolted Connections:
1. Tighten in accordance with AISC 303 and 360.
2. Hardened washers:
a. Provide hardened washers at the locations required by AISC for structural joints; include slip-critical connections using slotted or oversized holes or bolts in accordance with ASTM F 3125.
b. Use beveled style and extra thickness where required.
c. Do not substitute direct tension indicators for hardened flat washers at slotted and oversized holes.

3. For bearing type connections not fully tensioned, tighten to a snug-tight condition; use a hardened washer over slotted or oversized holes in outer members.
4. Use tension-control bolts only in snug-tight bearing connections.

N. Fully tensioned bolted connections:
1. Use direct tension indicators at slip-critical and fully tensioned bearing connections.
2. Position within the bolted assembly in accordance with ASTM F 959.
3. Install bolts, with direct tension indicators plus hardened washers as required, in the holes of the assembly and tighten until members are in firm contact and fasteners are uniformly tight.
4. Final tighten bolts by beginning at the most rigid part of the bolted connection and progressing toward the free edges until direct tension indicators are compressed to the average gap equal to or less than shown in Table 2, ASTM F 959.

O. Remove temporary shoring and bracing members after permanent members are in place and final connections are made.

P. Installation Tolerances:
1. Maximum variation from plumb: 1/4 inch per story, noncumulative.
2. Maximum variation from level: 1/4 inch in 10 feet, noncumulative.
3. Maximum offset from alignment of adjacent members: 1/4 inch.
4. Displacement of centerline of exterior columns and columns adjacent to elevator shafts: Maximum 1/16 inch per story.

Q. Placement of Grout: As specified in SECTION 03 62 00.

R. Finish Coating: As specified in SECTION 09 90 00.

3.2 QUALITY CONTROL

A. For testing and inspection services provided by an outside entity:
1. Inspect steel elements for conformance to the specified requirements including:
a. Location and adequacy of bracing.
b. Location and set of anchor bolts and other inserts.
c. Alignment, plumb, camber, and other required attributes.
2. Inspect strength bolted construction in accordance with AISC 303 and AISC 360 and as follows:
a. Visually inspect high-strength bolted connections.
b. Check at least three bolts of every diameter, length, and grade with a calibrated torque wrench for proper torque.
3. Inspect fully tensioned bearing and slip-critical connections in accordance with AISC 303 and AISC 360 and as follows:
a. Conduct a pre-installation test:
1) Prior to the start of Work, check at least three bolts of every diameter, length, and grade with a calibrated torque wrench for proper torque.
2) Include direct tension indicators and flat hardened washers to match the actual connection assembly.
b. Monitor the installation and tightening of direct tension indicators.
c. Monitor the condition of contact surfaces for slip-critical connections.
4. Inspect field welds in accordance with AWS D1.1 and as follows:
a. Visually inspect welds.
b. Test full penetration welds by ultrasonic method in accordance with ASTM E 164.
1) Welded structural components supporting machinery, cranes, or vehicular traffic shall be evaluated for cyclical loading criteria.
5. Inspect post-installed anchors, mechanical and adhesive, in accordance with the Manufacturer's requirements, including:
a. Preparation and cleaning of holes.
b. Anchor size and embedment length.
c. Adhesive installation and curing.
6. Make one set of six test cubes for each 1/3 cubic yard of grout placed or fraction thereof:
a. Mold and test cubes in accordance with ASTM C 109; three at 7 days and three at 28 days.
b. Prevent grout from expansion by the use of a top plate.

3.3 ADJUSTING

A. Touch up bolt heads, nuts, field welds, and abrasions in the shop coating with the same primer used in the shop.

B. Touch up welds and abrasions in galvanized members in accordance with ASTM A 780.

END OF SECTION

INTENTIONALLY BLANK

SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for steel joist framing.
- B. Related Sections:
  1. SECTION 05 05 23 – WELDING

1.2 REFERENCES
- A. American Welding Society (AWS):
  1. D1.1 – Structural Welding Code – Steel
- B. ASTM International (ASTM):
  1. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod, 60000 PSI Tensile Strength
- C. Steel Joist Institute (SJI):
  1. Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders
- D. The Society for Protective Coatings (SSPC):
  1. SP2 – Hand Tool Cleaning
  2. SP3 – Power Tool Cleaning
  3. Paint 15 – Steel Joist Shop Primer/Metal Building Primer

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Include joist identification numbers, types, locations, spacing, bridging, and attachments.
  2. Detailed elevation and section of each joist.
  3. Special reinforcing, connections to supported items, and extra members.
  4. Joists for which standard load tables are not applicable shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
- B. Submit a certification letter stating compliance with SJI Standard Specifications.

1.4 QUALITY ASSURANCE
- A. Fabricator and Erector Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Welder Qualifications: As specified in SECTION 05 05 23.
- C. Design Requirements: Design connections not detailed on the Drawings shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
- D. Steel joists, joist girders, and bridging shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store joists off the ground; prevent contact with adjacent joists.
- B. Prevent damage to painted surfaces.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Canam Steel
- B. SMI Joist Company
- C. Socar, Inc.
- D. Vulcraft Div., Nucor Corporation

2.2 MATERIALS
- A. Steel Shapes: In accordance with SJI standard specifications.

2.3 ACCESSORIES
- A. Bolts shall be in accordance with ASTM A 307, Grade A, 60 ksi minimum tensile strength; provide compatible hexagonal nuts and plain washers.
- B. Primer Paint: In accordance with SSPC Paint 15, Type 1, red oxide.
- C. Welding Materials: The type required for the materials being welded, in accordance with AWS D1.1.

2.4 FABRICATION
- A. Fabricate joists to the requirements of SJI Standard Specifications.
- B. Provide end extensions as shown on the Drawings.
- C. Frame special sized openings in joist chord framing as shown on the Drawings.
- D. Provide bracing, bridging, anchors, connectors, and other accessories.
- E. Shop Prime Painting:
  1. Shop prime steel surfaces except:
     a. Surfaces to be welded.
     b. Surfaces to receive direct-applied fireproofing.
  2. Surface preparation: In accordance with SSPC SP2 or SSPC SP3.
  3. Application: One coat; follow the Coating Manufacturer's instructions.
  4. MDFT: 1.5 mils.

PART 3 EXECUTION

3.1 ERECTION
- A. Erect joists and accessories in accordance with SJI Standard Specifications.
- B. Provide for the distribution of concentrated loads incurred during erection.
- C. Complete bridging and permanently fasten joists in place before applying loads except as necessary for erection.
- D. Welding: As specified in SECTION 05 05 23.

E. Erect joists to the elevations, lines, and spacing as shown on the Drawings.
F. Coordinate the placement of anchors in other construction for securing bearing plates and wall attachments.
G. Frame floor and roof openings greater than 18 inches with supplementary framing.
H. Position and field weld joist chord extensions and wall attachments.
I. Joists damaged during construction shall be replaced or repaired with procedures submitted by the Joist Manufacturer.
J. Do not field cut or apply heat to joists or joist girders unless authorized, in writing, by the ENGINEER.
K. Concentrated Loads on Joists:
    1. Concentrated loads not shown on the Drawings shall be verified by the Joist Manufacturer for adequacy of joist design.
    2. The necessity of any reinforcement required for the concentrated loads applied to either the top or bottom chord shall be designed by the Joist Manufacturer.

3.2 QUALITY CONTROL
A. Testing and inspection services provided by an outside entity:
    1. Inspect joists for conformance to the specified requirements:
        a. Verify placement including location, alignment, and bearing.
        b. Inspect joist-to-seat and seat-to-support welds in accordance with AWS D1.1.
        c. Visually inspect bolted and welded connections.
        d. Verify installation of bridging or bracing.
        e. Verify connections for top and bottom chords.
        f. Verify the reinforcement of members with concentrated loads.

3.3 ADJUSTING
A. Clean welds and abrasions after erection and touch up with the same primer as originally applied.

END OF SECTION

SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for steel decking.

B. Related Sections:

1. SECTION 01 44 33 – MANUFACTURER'S SERVICES
2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
3. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
4. SECTION 01 91 00 (.01 or .02) – COMMISSIONING
5. SECTION 09 90 00 – PAINTING AND COATING
6. SECTION 09 91 00 – ARCHITECTURAL PAINTING AND COATINGS

1.2 REFERENCES

A. American Iron and Steel Institute (AISI):

1. North American Specification for Design of Cold-Formed Steel Structural Members

B. American Welding Society (AWS):

1. D1.3 – Structural Welding Code – Sheet Steel

C. ASTM International (ASTM):

1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
3. A 792 – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot- Dip Process
4. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
5. C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
6. E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials
7. E 329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

D. California Department of Health Services:

1. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

E. FM Global (FMG):

1. Building Materials Approval Guide
2. Loss Prevention Data Sheet 1-28 – Wind Design

F. Steel Deck Institute (SDI):

1. Decking Design Manual No. 31 – Design Manual for Composite Decks, Form Decks and Roof Decks

G. Underwriters Laboratories (UL):

1. 209 – Standard for Cellular Metal Floor Raceways and Fittings
2. Electrical Construction Equipment Directory
3. Fire Resistance Directory

1.3 SUBMITTALS

A. Warranty documentation as specified in SECTION 01 60 00.

B. O&M documentation as specified in SECTION 01 78 23.

C. Action Submittals:

1. Product data: For each type of deck, the hanging devices including the material type, accessory, and product shown on the Drawings.
2. Shop Drawings:
   a. Include layout and types of deck panel, finishes, load capacities, noise reduction coefficients, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
   b. Erection drawings for roof deck and related accessory items showing profiles and material thicknesses, layout, anchorage, and openings as shown on the Drawings.

D. Informational Submittals:

1. Welding certificates.
2. Product certificates: For each type of steel deck.
3. Product test reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   a. Power-actuated mechanical fasteners.
   b. Acoustical roof deck.
4. Evaluation reports: For steel deck.
5. Field quality control reports.

1.4 QUALITY ASSURANCE

A. Factory/site demonstration testing requirements as specified in SECTION 01 91 00.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E 329 for testing shown on the Drawings.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.3.

D. Electrical Raceway Units: Provide UL labeled cellular floor-deck units in accordance with UL 209 and UL Electrical Construction Equipment Directory for use with standard header ducts and outlets for electrical distribution systems.

E. FMG Listing: Provide steel roof deck evaluated by FMG and the FMG Building Materials Approval Guide for Class 1 fire rating and Class 1-90 windstorm ratings.
F. Performance Requirements:
1. AISI specifications: In accordance with calculated structural characteristics of steel deck in accordance with AISI North American Specification for Design of Cold-Formed Steel Structural Members.
2. Fire-resistance ratings: In accordance with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of the applicable testing agency.
a. Indicate design designations from the UL Fire Resistance Directory or from the listings of another qualified testing agency.
3. Recycled content of steel products: Post-consumer recycled content plus 1/2 of pre-consumer recycled content not less than 25%.
4. Low-emitting materials: Paints and coatings shall be in accordance with the testing and product requirements of California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.
G. Training requirements for Manufacturer's training on the equipment as specified in SECTION 01 44 33.

1.5 DELIVERY, STORAGE, AND HANDLING
A. As specified in SECTION 01 60 00 and as follows:
1. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
2. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
a. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

1.6 WARRANTY
A. As specified in SECTION 01 60 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. EPIC Metals
B. Vulcraft

2.2 COMPONENTS
A. Roof Deck:
1. Roof deck: Fabricate panels, without top-flange stiffening grooves, in accordance with SDI Decking Design Manual No. 31, and with the following:
a. Prime-painted steel sheet: ASTM A 1008, structural steel, Grade 40 minimum, shop-primed with the Manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard gray.
b. Galvanized-steel sheet: ASTM A 653, structural steel, Grade 40 G90 zinc coating.
c. Galvanized and shop-primed steel sheet: ASTM A 653, structural steel, Grade 40 G60 (Z180) zinc coating; cleaned, pretreated, and primed with the Manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard gray.
d. Aluminum-zinc-alloy-coated steel sheet: ASTM A 792, structural steel, Grade 33 minimum, AZ50 aluminum-zinc-alloy coating.
e. Deck profile: As shown on the Drawings.
f. Cellular deck profile: As shown on the Drawings.
g. Profile depth: As shown on the Drawings.
h. Design uncoated-steel thickness: As shown on the Drawings.
i. Design uncoated-steel thicknesses; deck unit/bottom plate: As shown on the Drawings.
j. Span condition: Triple span or more.
k. Side laps: Overlapped.
B. Acoustical Roof Deck:
1. Acoustical roof deck: Fabricate panels, without top-flange stiffening grooves, in accordance with Decking Design Manual No. 31, and with the following:
a. Prime-painted steel sheet: ASTM A 1008, structural steel, Grade 40 minimum, shop-primed with the Manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard gray top surface with white underside.
b. Galvanized-steel sheet: ASTM A 653, structural steel, Grade 40 G90 zinc coating.
c. Galvanized and shop-primed steel sheet: ASTM A 653, structural steel, Grade 40 G60 zinc coating; cleaned, pretreated, and primed with the Manufacturer's standard baked-on, rust-inhibitive primer.
1) Color: Manufacturer's standard gray top surface with white underside.
d. Aluminum-zinc-alloy-coated steel sheet: ASTM A 792, structural steel, Grade 33 minimum, AZ50 aluminum-zinc-alloy coating.
e. Deck profile: As shown on the Drawings.
f. Cellular deck profile: As shown on the Drawings.
g. Profile depth: As shown on the Drawings.
h. Design uncoated-steel thickness: As shown on the Drawings.
i. Design uncoated-steel thicknesses; Deck unit/bottom plate: As shown on the Drawings.
j. Span condition: Triple span or more.
k. Side laps: Overlapped.

l. Acoustical perforations: Deck units with the Manufacturer's standard perforated vertical webs.
m. Sound-absorbing insulation: The Manufacturer's standard pre-molded roll or strip of glass or mineral fiber.
1) Factory install sound-absorbing insulation into cells of cellular deck.
2) Installation of sound-absorbing insulation in accordance with the Manufacturers recommendations.
n. Acoustical performance: NRC 0.90, tested in accordance with ASTM C 423.

C. Composite Floor Deck:
1. Composite floor deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, in accordance with Decking Design Manual No. 31, with the minimum section properties shown on the Drawings, and with the following:
a. Prime-painted steel sheet: ASTM A 1008, structural steel, Grade 33 minimum, with top surface phosphatized and unpainted and underside surface shop-primed with the Manufacturer's standard gray baked-on, rust-inhibitive primer.
b. Galvanized-steel sheet: ASTM A 653, structural steel, Grade 33 G60 zinc coating.
c. Galvanized and shop-primed steel sheet: ASTM A 653, structural steel, Grade 33, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with the Manufacturer's standard gray baked-on, rust-inhibitive primer.
d. Profile depth: 1 1/2 inches or as shown on the Drawings.
e. Design uncoated-steel thickness: 0.0598 inch or as shown on the Drawings.
f. Span condition: Triple span or more.

2.3 ACCESSORIES
A. General: Provide the Manufacturer's standard accessory materials for deck that are in accordance with requirements shown on the Drawings.
B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359 inch design uncoated thickness, of the same material and finish as deck; of the profile shown on the Drawings or required for application.
F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of the same material and finish as deck, and of the thickness and profile recommended by SDI Decking Design Manual No. 31 for overhang and slab depth.
G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of the same material, finish, and thickness as deck unless otherwise shown on the Drawings.
H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8 inch minimum diameter.
J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of the same material and finish as deck. For drains, cut holes in the field.
K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of the same material and finish as deck, with 3 inch wide flanges and sloped recessed pans of 1 1/2 inches minimum depth. For drains, cut holes in the field.
L. Galvanizing Repair Paint: ASTM A 780.
M. Repair Paint: The Manufacturer's standard rust-inhibitive primer of the same color as primer.

2.4 FABRICATION
A. Acoustical roof deck shall have continuous dovetail shaped ribs spaced 8 inches on center or as shown on the Drawings. The profile shall be 5 1/2 inches deep or as shown on the Drawings.
B. The design thickness and minimum section properties shall be as shown on the Drawings.
C. Roof deck panels shall have positive registering sidelaps that can be fastened by welds or screws.
D. Acoustical roof deck panels shall be fabricated with perforated holes. Perforated areas shall be located in the areas between the dovetail-shaped ribs.

PART 3 EXECUTION

3.1 PREPARATION
A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. General:
1. Install deck panels and accessories in accordance with applicable specifications and commentary in SDI Decking Design Manual No. 31, the Manufacturer's written instructions, and the requirements in this Section.
2. Install temporary shoring before placing deck panels if required to meet deflection limitations.
3. Locate deck bundles to prevent the overloading of supporting members.
4. Place deck panels on the supporting frame and adjust to final position with ends accurately aligned and bearing on the supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
a. Align cellular deck panels over the full length of cell runs and align cells at the ends of abutting panels.
5. Place deck panels flat and square and fasten to the supporting frame without warp or deflection.

6. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
7. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
8. In accordance with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
9. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with the Deck Manufacturer's written instructions.

B. Roof-Deck Installation:
1. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter shown on the Drawings or arc seam welds with an equal perimeter that is not less than 1 1/2 inches long, and as follows:
   a. Weld diameter: 5/8 inch, nominal.
   b. Weld spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28 – Wind Design unless otherwise shown on the Drawings.
   c. Weld washers: Install weld washers at each weld location.
2. Side-lap and perimeter edge fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as follows:
   a. Mechanically fasten with self-drilling, No. 12 diameter or larger, carbon-steel screws.
   b. Fasten with a minimum of 1 1/2 inch long welds.
3. End bearing: Install deck ends over the supporting frame with a minimum end bearing of 1 1/2 inches, with end joints as follows:
   a. End joints: Lapped 2 inches minimum.
4. Roof sump pans and sump plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.
   a. Install reinforcing channels or zees in ribs to span between supports and weld.
5. Miscellaneous roof-deck accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with the Deck Manufacturer's instructions. Weld to substrate to provide a complete deck installation.
   a. Weld cover plates at changes in direction of roof-deck panels unless otherwise shown on the Drawings.
6. Flexible closure strips: Install flexible closure strips over partitions, walls, and where shown on the Drawings. Install with adhesive in accordance with the Manufacturer's instructions to ensure complete closure.
7. Sound-absorbing insulation: Installation into topside ribs of deck in accordance with the Manufacturer’s recommendations.

C. Floor-Deck Installation:
1. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter shown on the Drawings and as follows:
   a. Weld diameter: 5/8 inch, nominal.
   b. Weld spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart. Space and locate other welds as shown on the Drawings.
   c. Weld washers: Install weld washers at each weld location.
2. Side-lap and perimeter edge fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
   a. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
   b. Mechanically clinch or button punch.
   c. Fasten with a minimum of 1 1/2 inch long welds.
3. End bearing: Install deck ends over supporting frame with a minimum end bearing of 1 1/2 inches, with end joints as follows:
   a. End joints: Lapped.
4. Pour stops and girder fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise shown on the Drawings.
5. Floor-deck closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
6. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise shown on the Drawings.

3.3 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A 780 and the Manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation and apply repair paint.
1. Apply repair paint, of the same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
2. Wire brushing, cleaning, and repair painting of bottom deck surfaces as specified in SECTION 09 90 00 and SECTION 09 91 00.

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in SECTION 09 90 00 and SECTION 09 91 00.

D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at the time of Substantial Completion.

3.4 QUALITY CONTROL

A. ORT Prerequisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER and the ENGINEER, shall be paid by the CONTRACTOR.

B. Testing Agency: The OWNER will engage qualified testing agency to perform tests and inspections.

C. Field welds will be subject to inspection.

D. The testing agency shall report inspection results promptly and in writing to the CONTRACTOR and the ENGINEER.

E. Remove and replace Work that is not in accordance with specified requirements.

F. Additional inspecting, at the CONTRACTOR's expense, will be performed to determine compliance of corrected Work with specified requirements.

END OF SECTION

INTENTIONALLY BLANK

SECTION 05 31 23
STEEL ROOF DECKING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for steel roof decking.
- B. Related Sections:
  1. SECTION 05 05 23 – WELDING

1.2 REFERENCES
- A. American Welding Society (AWS):
  1. D1.1 – Structural Welding Code – Steel
- B. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. A 924 – Standard Specification for General Requirements for Steel Sheet Metallic-Coated by the Hot-Dip Process
- C. Steel Deck Institute (SDI):
  1. Decking Design Manual No. 31 – Design Manual for Composite Decks, Form Decks and Roof Decks
- D. The Society for Protective Coatings (SSPC):
  1. Paint 20 – Zinc-Rich Coating Inorganic and Organic

1.3 SUBMITTALS
- A. Product Data: Deck profile, characteristics, dimensions, structural properties, and finish.
- B. Shop Drawings: Indicate decking types and weld locations plan, support locations, projections through decking, openings, pertinent details, and accessories.
- C. Quality Control Submittal: A certificate of compliance that the steel roof deck is in in accordance with SDI Decking Design Manual No. 31 – Design Manual for Composite Decks, Form Decks and Roof Decks.

1.4 QUALITY ASSURANCE
- A. Manufacturer and Installer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Design Requirements: Design decking including layout, spans, fasteners, and joints shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
- C. Welder Qualifications: As specified in SECTION 05 05 23.
- D. Perform Work in accordance with the SDI's Decking Design Manual No. 31.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store decking off the ground at the site, with one end elevated to provide drainage; protect with a properly vented waterproof covering.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. BlueScope Steel Limited
- B. Cordeck
- C. Epic Metals Corporation
- D. United Steel Deck, Inc.
- E. Verco Manufacturing Company
- F. Vulcraft Div., Nucor Corporation

2.2 MATERIALS
- A. Steel Sheet: Structural steel, in accordance with ASTM A 653, G90 coating class.
- B. Before forming, the sheets shall receive a hot-dip protective coating of zinc in accordance with ASTM A 924 with the following minimum coating class, in accordance with ASTM A 653:
  1. Corrosive environments: G90.
  2. Other locations: G60.

2.3 ACCESSORIES
- A. Touch Up Paint: In accordance with SSPC Paint 20, Type I or II.
- B. Fasteners: Hot-dip galvanized steel, self-tapping.
- C. Welding Materials: The type required for the materials being welded, in accordance with AWS D1.1.

2.4 FABRICATION
- A. Fabricate deck and accessories in accordance with SDI's Decking Design Manual No. 31.
- B. Provide deck types, minimum grades, and gauges as shown on the Drawings.
- C. Side Joints: Lapped.
- D. Form units to span three or more supports, with lapped ends and nesting side laps.
- E. Accessory Strips: Fabricate metal closure strips and cover plates of 20 gauge sheet steel.
- F. Roof Sump Pans: Fabricate of 14 gauge galvanized sheet steel, flat bottom, sloped sides, recessed 1 1/2 inches below the roof deck surface, 3 inch wide bearing flange, with joints sealed watertight.
- G. Apply the Manufacturer's standard painted finish, sprayed and baked, to decking and accessories.
- H. For a roof deck painted in the field, coordinate with the ENGINEER and comply with these additional requirements:
  1. Each side of the galvanized roof deck shall be primed with the Manufacturer's baked-on, lead and chromate-free primer. The galvanized deck shall be cleaned, pretreated, and prepared prior to priming in accordance with the Coating Manufacturer's requirements.
  2. For decks in aggressive environments, after fabrication or assembly of the panel, the exposed surface and the inside periphery of the perforations shall receive factory-applied epoxy primer. The primer shall be oven cured to enhance adhesion and durability characteristics.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install decking and accessories in accordance with the Manufacturer's instructions, SDI's Decking Design Manual No. 31, and approved Shop Drawings.
B. Lap ends 2 inches to 4 inches. Center laps over supports.
C. Do not stretch or contract side lap interlocks.
D. Place deck units flat and square, without warp or deflection.
E. Provide a minimum 2 inch bearing on steel supports and a minimum 4 inch bearing on other materials.
F. Weld decking to supporting members through welding washers as specified in SECTION 05 05 23. Provide weld washers for decking thinner than 22 gauge.
G. Mechanically fasten decking to supporting members as shown on the Drawings.
H. Mechanically fasten side laps between adjacent decking units as shown on the Drawings, or at a maximum of 18 inches on center. In corrosive environments, fasteners shall be SST.
I. Cut and fit decking and accessories at the perimeter and around projections and openings. Make cuts neat and trim.
J. Position roof sump pans with flange bearing on the top surface of the deck. Fasten at each deck flute.
K. Provide strips for the support of roof insulation where rib openings in the top surface of the roof decking occur adjacent to the edges and the openings. Weld strips into position.
L. Provide minimum 6 inch wide cover strips where the deck changes direction. Weld or mechanically fasten strips into position.
M. Install closures and angle flashings to close openings between decking, walls, and columns.
N. Concentrated Loads: Do not hang concentrated loads exceeding 50 lbs from the roof deck.

3.2 QUALITY CONTROL

A. Testing and inspection services provided by an outside entity:
    1. Inspect decking for conformance to the requirements of the Contract Documents, including the following:
        a. Deck type and gauge.
        b. Deck placement and alignment.
        c. Welds and weld pattern.
        d. Fastener types, locations, quantities, and placement.

3.3 ADJUSTING

A. Wire brush and clean scarred areas, welds, and rust spots on decking units and supporting steel members.
B. Touch up the paint finish with the same paint used in shop; apply as recommended by the Manufacturer.
C. Touch up galvanized coatings with galvanizing repair paint; apply as recommended by the Manufacturer.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for metal fabrications.

B. Related Sections:

1. SECTION 03 15 05 – ANCHORING TO CONCRETE
2. SECTION 05 05 23 – WELDING
3. SECTION 05 12 00 – STRUCTURAL STEEL
4. SECTION 05 51 02 – ALUMINUM STAIRS
5. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. ASTM International (ASTM):

1. A 36 – Standard Specification for Carbon Structural Steel
2. A 47 – Standard Specification for Ferritic Malleable Iron Castings
3. A 48 – Standard Specification for Gray Iron Castings
4. A 108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
5. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. A 242 – Standard Specification for High-Strength Low-Alloy Structural Steel
7. A 276 – Standard Specification for Stainless Steel Bars and Shapes
8. A 283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
9. A 354 – Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
10. A 480 – Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
11. A 489 – Standard Specification for Carbon Steel Lifting Eyebolts
12. A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
13. A 501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
14. A 510 – Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
15. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
16. A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
17. A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
18. A 786 – Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
19. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
20. A 1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
21. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
22. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
23. B 241 – Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
24. C 881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
25. D 746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
26. D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique
27. D 1525 – Standard Test Method for Vicat Softening Temperature of Plastics
28. F 436 – Standard Specification for Hardened Steel Washers
29. F 468 – Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
30. F 844 – Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

1.3 SUBMITTALS

A. Product Data: For the manufactured products used in metal fabrication and nosings for exterior concrete steps.

B. Shop Drawings: Dimensions, metal thicknesses, finishes, joints, attachments, and relationship of Work to adjacent construction.

C. Finish Data.

D. Quality Control Submittals:

1. Provide the Manufacturer's design and calculations prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado for platform structures.
2. Provide load tables for grating.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Anti-seizing Lubricant:
   1. Loctite Co., ITW Permatex, Inc.

2.2 MATERIALS

A. Carbon Steel:
   1. Shapes: In accordance with ASTM A 36.
   2. Plate for lifting lugs: In accordance with ASTM A 242.
   3. Other plate: In accordance with ASTM A 283.
   4. Checkered plate:
      a. In accordance with ASTM A 786.
      b. Pattern: Diamond plate pattern – diamond.
      c. Thickness: As shown on the Drawings.
      d. Galvanize after fabrication.
   5. Sheet:
      a. Uncoated, structural: In accordance with ASTM A 1008; Grade A.
      b. Uncoated, non-structural: In accordance with ASTM A 1008; Commercial.
      c. Galvanized, structural: In accordance with ASTM A 653; Grade A, unless otherwise required by design loading.
   6. Pipe: In accordance with ASTM A 501.
   7. Tube: In accordance with ASTM A 500.
   8. Bars: In accordance with ASTM A 108.

B. CI: In accordance with ASTM A 48, Class 30, or ASTM A 47.

C. Aluminum:
   1. Extrusions: In accordance with ASTM B 221, 6061-T6 alloy and temper.
   2. Sheet: In accordance with ASTM B 209, alloy and temper best suited to application.
   3. Pipe: Extruded, anodizing quality, 6063 aluminum pipe, Schedule 40, in accordance with ASTM B 241.
   4. Perforated metal:
      a. In accordance with ASTM B 209, Type: 3003-H14 or 5052-H32.
      b. Thickness: Minimum 12 gauge.
      c. Pattern: 3/16 inch round holes at 1/4 inch staggered centers, finished ends, minimum side margins, and 2 inch end margins.
      d. Open area: Approximately 50%.
   5. Bolts: In accordance with ASTM F 468, Alloy 2024-T4.

D. SST:
   1. Bars and shapes: In accordance with ASTM A 276; Type 316.
   2. Other SST: Rollable temper, in accordance with ASTM A 480 or ASTM A 666; Type 304 or 316.
   3. Bolts, nuts, and washers: In accordance with ASTM A 354.

E. Steel Bar Gratings:
   1. Formed steel sheet for welding, riveting, or pressure locking: Rectangular shape, in accordance with ASTM A 1011.
   2. Steel rod for cross bars: In accordance with ASTM A 510.

F. Aluminum Bar Gratings: As specified in SECTION 05 51 02.

2.3 ACCESSORIES

A. Exposed Screws: The same material as the metal being fastened; Phillips flat head, countersunk, unless otherwise noted.

B. Steel: Hexagonal head type, as specified in SECTION 05 12 00.
   1. Galvanized steel bolts: Provide zinc coating in accordance with ASTM A 153.

C. Eye Bolts: Type 2 shoulder type, in accordance with ASTM A 489.

D. Threaded Rods: In accordance with ASTM A 36.

E. Flat Washers (Unhardened): In accordance with ASTM F 844, with zinc coating in accordance with ASTM A 153.

F. Flat Washers (Hardened): In accordance with ASTM F 436.

G. Anchor Bolt Sleeves:
   1. High-density PE plastic:
      a. Single unit construction with deformed sidewalls.
      b. Self-threaded top of sleeve.
      c. Material requirements:
         1) Plastic: High-density PE.
         2) Density: In accordance with ASTM D 1505.
         3) Vicat softening point: In accordance with ASTM D 1525.
         4) Brittleness temperature: In accordance with ASTM D 746.
   2. Fabricated steel sleeve: In accordance with ASTM A 36.

H. Anti-Seizing Lubricant: Containing substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

I. Anchoring Systems for Concrete and Masonry: As specified in SECTION 03 15 05.

J. Primer Paint: As specified in SECTION 05 12 00.

K. Anchoring Cement: Non-shrink cementitious or two-component epoxy type.

L. Nosings for Exterior Concrete Steps:
   1. Cast aluminum with cross hatched abrasive surface.
   2. Nosing: 1 inch minimum.
   3. Depth: 3 inches minimum.
   4. Length: step width less 3 inches each end.

2.4 FABRICATION

A. Fit and shop assemble items in the largest practicable sections for delivery to the site.
B. Use materials clean and free of mill scale, flake rust, and rust pitting.
C. Fabricate to the dimensions shown on the Drawings or accepted on the Shop Drawings using proven details of fabrication and support.
D. Fabricate exposed Work true to line and level with accurate angles and smooth surfaces and straight sharp edges.
E. Fabricate items with joints tightly fitted and secured.
F. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown on the Drawings. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.
G. Grind exposed joints flush and smooth with the adjacent finish surface. Make exposed joints butt tightly, flush, and hairline.
H. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with the design of the component.
I. Supply the components required for the anchorage of fabrications. Fabricate anchors and related components of the same material and finish as the fabrication.
J. Conceal fastenings where possible.
K. Welding: As specified in SECTION 05 05 23.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide setting drawings, templates, instructions, and directions for the installation of anchors, inserts, sleeves, anchor bolts, and miscellaneous items that are to be embedded in concrete or masonry construction.
B. Field Measurement: Check the actual locations of construction to which metal fabrications shall fit by accurate field measurement prior to fabrication. Show recorded measurements on the final Shop Drawings.

3.2 INSTALLATION

A. Install items in accordance with approved Shop Drawings.
B. Install components plumb, level, rigid, and free of rack.
C. Set accurately in location, alignment, and elevation.
D. Allowable Tolerances:
   1. Maximum variation in straightness, elevation, plumb, level, line or true: 1/4 inch in 10 feet.
E. Welding: As specified in SECTION 05 05 23.
F. Provide the appropriate type and size of anchorage devices and fasteners for securing the fabrications to in-place construction that is adequate to support anticipated loads.
G. Install sleeved components with anchoring cement.
H. Use anti-seizing lubricant on SST threads.
I. Prevent the contact of dissimilar metals and aluminum and concrete from each other by use of zinc-rich paint, bituminous coating as specified in SECTION 09 90 00, or nonabsorptive gaskets.

3.3 ADJUSTING

A. Clean and touch up damaged primer paint with the same product as applied in the shop.
B. Clean and touch up galvanized coatings at welded and abraded surfaces in accordance with ASTM A 780, Annex A2.

END OF SECTION

INTENTIONALLY BLANK

SECTION 05 51 01
STEEL STAIRS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for steel stairs.
- B. Related Sections:
  1. SECTION 03 15 05 – ANCHORING TO CONCRETE
  2. SECTION 05 05 23 – WELDING

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 36 – Standard Specification for Carbon Structural Steel
  2. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  3. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  4. A 283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
  5. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
  6. A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  7. A 501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
  8. A 780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
  9. F 3125 – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
- B. National Association of Architectural Metal Manufacturers (NAAMM):
  1. AMP 510 – Metal Stairs Manual
  2. MBG 531 – Metal Bar Grating Manual
- C. The Society for Protective Coatings (SSPC):
  1. Paint 15 – Steel Joist Shop Primer/Metal Building Primer

1.3 SUBMITTALS
- A. Product Data: Manufacturer's product data.
- B. Shop Drawings:
  1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
  2. Indicate welded connections using standard AWS welding symbols; indicate net weld lengths.
- C. Quality Control Submittals: Provide the Manufacturer's design and calculations prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado for stairs and components.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications: A minimum of 5 years documented experience in the Work of this Section.
- B. Erector Qualifications: A minimum of 5 years documented experience in Work of this Section.
- C. The design shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
- D. System Description:
  1. Stair assembly design requirements:
     a. Fabricate the stair assembly to support a uniform live load of 100 lbs/sf and a concentrated load of 300 lbs, with a maximum deflection of 1/240 of the span.
     b. Concentrated and uniform loads do not need to be applied simultaneously.
  2. Guardrail and handrail design requirements:
     a. Fabricate guardrails and handrails to resist the following without damage or permanent set:
        1) A concentrated load of 200 lbs at any point in any direction at the top.
        2) A uniform load of 50 lbs/lf applied in any direction on the top.
        3) Maximum deflection under loading: 1/180 of the span.
     b. Fabricate intermediate rails and balusters to resist the following without damage or permanent set: A horizontally applied normal load of 50 lbs on an area equal to 1 sf including openings and space between rails.
     c. Concentrated and uniform loads do not need to be applied simultaneously.
     d. Fabricate the stair assembly in accordance with NAAMM AMP 510, Industrial Class.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Steel Tread Gratings:
  1. McNichols Company

2.2 MATERIALS
- A. Steel:
  1. Sections: In accordance with ASTM A 36.
  2. Plate: In accordance with ASTM A 283.
  3. Pipe: In accordance with ASTM A 501.
  4. Tube: In accordance with ASTM A 500.
  5. Tread gratings:
     a. Welded type with plain top surface in accordance with NAAMM MBG 531.

b. Bearing bars: Depth as required by length, 1 inch minimum, depth, 1 3/16 inch spacing, cross bars spaced 4 inches on center.
c. Nosing: Checker plate.
d. Length: As required for stair width.
e. Finish: Hot-dipped galvanized.

2.3 ACCESSORIES

A. Bolts, Nuts, and Washers: In accordance with ASTM A 307.
B. Anchorage to Concrete or Masonry: As specified in SECTION 03 15 05.
C. High-Strength Bolts: In accordance with ASTM F 3215, Type 1.
D. Galvanized Steel Bolts and Nuts: In accordance with ASTM A 307 or A 36, with zinc coating in accordance with ASTM A 153.
E. Primer Paint: In accordance with SSPC Paint 15, Type 1, red oxide.

2.4 FABRICATION

A. Fit and shop assemble components in the largest practicable sections for delivery to the site.
B. Fabricate exposed Work true to line and level with accurate angles, smooth surfaces, and straight, sharp edges.
C. Fabricate components with joints tightly fitted and secured.
D. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown on the Drawings. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.
E. Continuously weld connections.
F. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline.
G. Supply the components required for the anchorage of fabrications. Fabricate anchors and related components of the same material and finish as fabrication.
H. Accurately form the components required for the anchorage of stairs, landings, and railings to each other and to the building structure.
I. Treads and Landings:
   1. Fabricate the treads and landings of metal bar grating, welded or bolted to supports as shown on the Drawings.
   2. Fabricate the stairs with open risers.
J. Guardrails and Handrails:
   1. Fabricate guardrails and handrails from steel pipe or tube stock as shown on the Drawings.
   2. Make bends uniform and free from buckles and other defects.
   3. Where the length exceeds that suitable for shipping and handling, fabricate in sections with concealed internal sleeves forming slip joints. Extend sleeves a minimum of 2 inches on both sides of the joint; field weld and grind smooth.
K. Provide galvanized or zinc-coated fasteners when stair components are fabricated from galvanized members.

2.5 FINISHES

A. Steel: Galvanized in accordance with ASTM A 123.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install components plumb and level, accurately fitted, and free from distortion and defects.
B. Provide anchors, angles, hangers, and struts required for connecting the stairs to the structure.
   1. Install mechanical or adhesive anchors as specified in SECTION 03 15 05.
C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until the completion of the erection and installation of permanent attachments.
D. Field weld components shown on the Shop Drawings. Perform field welding as specified in SECTION 05 05 23.
E. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible.
F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.
G. Installation Tolerances:
   1. Maximum variation from plumb: 1/4 inch per landing, noncumulative.
   2. Maximum offset from true alignment: 1/4 inch.

3.2 ADJUSTING

A. Clean and touch up galvanized coatings at welded and abraded surfaces in accordance with ASTM A 780, Annex A2.

END OF SECTION

SECTION 05 51 02
ALUMINUM STAIRS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for aluminum stairs.
- B. Related Sections:
  1. SECTION 03 15 05 – ANCHORING TO CONCRETE
  2. SECTION 05 05 23 – WELDING

1.2 REFERENCES
- A. Aluminum Association (AA):
  1. Aluminum Design Manual, Specifications for Aluminum Structures
- B. American Welding Society (AWS):
  1. D1.2 – Structural Welding Code – Aluminum
- C. ASTM International (ASTM):
  1. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  2. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- D. National Association of Architectural Metal Manufacturers (NAAMM):
  1. AMP 510 – Metal Stairs Manual
  2. MBG 531 – Metal Bar Grating Manual

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
  2. Indicate welded connections using standard AWS welding symbols; indicate net weld lengths.
- B. Samples: One of each type of grate, step, and support connection.
- C. Quality Control Submittals:
  1. Provide the Manufacturer's design and calculations prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado for stairs and components.
  2. A certificate of compliance for each specified product.
  3. Mill certificates.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Erector Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- C. Welding in accordance with AWS D1.2.
- D. System Description:
  1. Design requirements:
     a. Fabricate the stair assembly to support a uniform live load of 100 psf and a concentrated load of 300 lbs, with a maximum deflection of 1/240 of the span.
     b. Concentrated and uniform loads do not need to be applied simultaneously.
  2. Fabricate the stair assembly in accordance with NAAMM AMP 510, Industrial Class.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Grating:
  1. AMICO-Klemp Corporation
  2. Harsco Industrial IKG, Swage locked I-Bar grating Type IB
  3. McNichols Company, Inc.
  4. Ohio Gratings, Inc.
- B. Removable Fastener Clips and Bolts:
  1. Struct-Fast, Inc., Grate-Fast FG
- C. Partially Removable Anchors:
  1. Studs:
     a. Nelson Stud Welding Co.
  2. Hat bracket:
     a. Struct-Fast, Inc.
- D. Grated Stair Treads:
  1. Harsco Industrial IKG, Swage Locked I-Bar Grating Type IB
- E. Extruded Aluminum Frame Supports:
  1. Thompson Fabricating, LLC

2.2 MATERIALS
- A. Aluminum:
  1. Extrusions: In accordance with ASTM B 221, 6061-T6 alloy and temper.
  2. Grating bearing bars and plates: In accordance with ASTM B 221, 6061-T6 alloy and temper.

2.3 ACCESSORIES
- A. Bolts, Nuts, and Washers: SST, in accordance with ASTM F 593.
- B. Removable Fastener Clips and Bolts:
  1. Removable from above the grating walkway surface.
  2. Hat bracket: In accordance with ASTM F 593, Type 316 SST.

3. Bolt: In accordance with ASTM F 593, Type 316 SST.

C. Anchorage to Concrete or Masonry: As specified in SECTION 03 15 05.

2.4 FABRICATION

A. Fit and shop assemble components in the largest practicable sections for delivery to the Work site.

B. Fabricate components with joints tightly fitted and secured.

C. Continuously weld connections in the shop and bolt connections in the field.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to a small uniform radius.

E. Supply the components required for the anchorage of fabrications. Fabricate anchors and related components of the same material and finish as fabrication.

F. Accurately form the components required for the anchorage of stairs, landings, and railings to each other and to the building structure.

G. Aluminum Grating:

1. Minimum bearing: In accordance with NAAMM MBG 531.
2. Space bearing bars at 1 3/16 inch center-to-center and orient perpendicular to traffic.
3. Space cross bars at 4 inches on center.
4. Banding:
   a. Minimum 3/16 inch.
   b. Flush at the top surface and 1/4 inch clear of the bottom surface.
   c. The same material as the grating; in accordance with NAAMM MBG 531.

H. Grated Stair Treads:

1. Provide plate or angle connection at each end of the tread to the stair stringers.
2. Provide one piece of pre-manufactured aluminum grating tread with a non-slip, abrasive edge and a 1 inch minimum nosing.

I. Supports:

1. Provide connections as shown on the Drawings; where not shown on the Drawings, design and provide connections as specified in this Section.
2. Seat angles and beams where shown on the Drawings:
   a. The same material as the grating.
   b. Extruded aluminum frame with a slot for recessed grating clips for aluminum I-bar type grating.
3. Coordinate dimensions and fabrication with the grating to be supported.
4. Coordinate dimensions with increased depth due to serrations.
5. Welded frames with anchors: Continuously welded.
6. In accordance with AA Aluminum Design Manual, Specifications for Aluminum Structures.

2.5 FINISHES

A. Aluminum: Mill finish.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install components plumb and level, accurately fitted, and free from distortion and defects.

B. Provide the anchors, angles, hangers, and struts required for connecting the stairs to the structure.

1. Install SST mechanical or adhesive anchors as specified in SECTION 03 15 05.

C. Allow for erection loads and for sufficient temporary bracing to maintain true alignment until the completion of the erection and the installation of the permanent attachments.

D. Welding: As specified in SECTION 05 05 23.

E. Field bolt to match shop bolting. Conceal bolts and screws whenever possible.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

G. Protect aluminum that is in contact with concrete or grout with a heavy coat of bituminous paint.

H. Installation Tolerances:

1. Maximum variation from plumb: 1/4 inch.
2. Maximum offset from true alignment: 1/4 inch.

3.2 ADJUSTING

A. Clean and touch up the finish at welded and abraded surfaces to match the shop finish.

END OF SECTION

SECTION 05 52 02
ALUMINUM RAILINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for aluminum railings.
- B. Related Sections:
  1. SECTION 03 15 05 – ANCHORING TO CONCRETE
  2. SECTION 05 50 00 – METAL FABRICATIONS
  3. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  2. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- B. International Code Council (ICC):
  1. International Building Code (IBC)
- C. International Code Council, Evaluation Service, Inc. (ICC-ES):
  1. ESR – Evaluation Service Report
- D. Occupational Safety and Health Administration (OSHA):
  1. 29 CFR 1910 – Occupational Safety and Health Standards

1.3 DEFINITIONS
- A. Toeboard: A vertical barrier at floor level that is usually erected on handrails along exposed edges of floor or wall openings, platforms, ramps, or stairs to prevent miscellaneous items from falling through.

1.4 SUBMITTALS
- A. Product Data: Manufacturer's literature and catalog data on handrails and components.
- B. Shop Drawings:
  1. Indicate handrail profiles, sizes, connections, anchorage, size and type of fasteners, and accessories; provide Project-specific scale plans and elevations of handrails.
  2. Design data: Calculations or test data using design performance loads if a shop-fabricated item utilizing a performance specification is used; include:
     a. Bending stress in, and deflection of, posts.
     b. Stress in post base connection.
     c. Calculation of anchorage forces and comparison of these forces to ICC IBC recommendations regarding safe allowable design loads of anchorages.
     d. For concrete anchor spacings less than twelve anchor diameters and edge distances less than six anchor diameters, make a reduction in allowable pullout and shear values. Use the published ICC-ES ESR values for anchors without special inspection or provide an independent laboratory inspection service for ICC-ES evaluation. Report values with special inspection.
- C. Quality Control Submittals:
  1. Provide the Manufacturer's design and calculations prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado for railings and components.
  2. Special inspection:
     a. The Manufacturer's instructions for special inspection of concrete anchors.
     b. The special inspection report in accordance with article tests and inspections.
  3. Test reports: Test data may supplement load calculations providing the data covers the complete handrail system, including anchorage:
     a. Test data for handrail and components showing load and deflection due to load, in enough detail to prove the handrail is strong enough and satisfies federal, state, and local standards, regulations, code requirements, and OSHA 29 CFR 1910 using the design loads specified. Include test data for the following:
        1) Railing and post connections.
        2) Railing wall connections.
        3) Post and base connections.
        4) Railing expansion joint connections.
        5) Railing gate assembly, including latch and gate stop; both the gate latch and the stop are to support the required loads applied, independent of one another.
        6) Railing gate hinges.
     b. Deflection criteria: In accordance with the design loads specified.
     c. Concrete anchors: Calculations and test data for review prior to use, on anchors other than those specified.
  4. Mill certificates.

1.5 QUALITY ASSURANCE
- A. System Description:
  1. Design requirements:
     a. Design connections that are not detailed on the Drawings shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
     b. Fabricate guardrails and handrails to resist the following without damage or permanent set:
        1) A concentrated load of 200 lbs at any point in any direction at the top.
        2) A uniform load of 50 lbs/lf applied in any direction on the top.
        3) Maximum deflection under loading: 1/180 of the span.

c. Fabricate intermediate rails and balusters to resist the following without damage or permanent set: A horizontally applied normal load of 50 lbs on an area equal to 1 sf including openings and space between rails.
d. Concentrated and uniform loads do not need to be applied simultaneously.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Aluminum Handrails:
1. Shop assemble into practicable modules of lengths that do not exceed 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized handrail pipe and posts with protective plastic wrap.

1.7 SITE CONDITIONS
A. Environmental Requirements – Thermal Movements:
1. Allow for thermal movement resulting from following the maximum range in ambient temperature in the design, fabrication, and installation of handrails to prevent detrimental effects.
2. Base the design calculation on the actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
3. Temperature change is the difference between the high or low temperature and the installation temperature.
4. Temperature change range: 70°F, ambient; 100°F, material surfaces.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Concrete Top Mount Post Base for Narrow Walls and Curbs:
1. Moultrie Manufacturing Co., Part No. WII4HB and WII2HB
2. Thompson Fabricating, LLC, Part No. TBF-3.4 and Part No. TBF-3.2
B. Concrete Side Mounted Handrail Bracket:
1. Moultrie Manufacturing Co., Part No. WIISMB
2. Thompson Fabricating, LLC, Part No. TSM-1.50
C. Aluminum Tee Fittings:
1. Moultrie Manufacturing Co., Part Nos. WIIT40 and WIIT40/05
2. Thompson Fabricating, LLC, Part Nos. TF-1 and TX-1
D. Aluminum Elbow Fittings:
1. Thompson Fabricating, LLC, Part Nos. TE-1, TE-2, and TE-3
E. Aluminum Splice Lock:
1. Moultrie Manufacturing Co., Part No. WIIS40
2. Thompson Fabricating, LLC, Part No. SL-1
F. Aluminum Expansion Joint Splice:
1. Thompson Fabricating, LLC, Part No. ES-1
G. Formed Aluminum Wall Flange:
1. Thompson Fabricating, LLC, Part No. CF-2
H. Toeboards:
1. Moultrie Manufacturing Co., Part No. WIIKP20
2. Thompson Fabricating, LLC, Extruded Toeboard

2.2 MATERIALS
A. Aluminum Handrails:
1. Provide pre-engineered and prefabricated three rail handrails.
2. Pop rivets and glued railing construction is not permitted.
B. Rails, Posts, and Formed Elbows: In accordance with ASTM B 221, Extruded Alloy 6005-T5 or 6061-T6, with a minimum tensile strength of 38,000 psi and minimum yield strength of 35,000 psi.
1. Miscellaneous aluminum parts: In accordance with ASTM B 221, 6063-T6 or 6061-T6 extruded aluminum of adequate strength for loads.
2. Post and railing: Nominal 1 1/2 inch diameter:
a. Rails: 1.900 inch outside diameter by 0.145 inch wall thickness, Schedule 40.
b. Posts: 1.900 inch outside diameter by 0.200 inch wall thickness, Schedule 80.
c. Solid dowel interconnectors in accordance with ASTM B 221, 6105-T5 or 6061-T6 aluminum.
C. Fittings:
1. Handrail and post fittings: Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet the load requirements. Fittings shall match the color of the pipe in the handrails; sand cast parts are not permitted.
2. Concrete top mount post base: Four holes in the base for concrete anchors; for narrow walls or curbs, provide two holes in the base for concrete anchors with the required edge distance.
3. Concrete side mounted handrail bracket: Extruded aluminum, Alloy 6063-T6 with four holes for bolts or concrete anchors.
4. Concrete anchors for securing bases and brackets to concrete: In accordance with ASTM F 593, Type 316 SST 1/2-inch concrete anchors.
5. Toeboards and accessories material: Molded or extruded 6063 or 6061 aluminum.
6. Castings for handrails: Cast Al-mag with sufficient strength to meet load and test requirements.

2.3 ACCESSORIES
A. Fasteners: As specified in SECTION 05 50 00.
B. Anchor Bolts and Concrete Anchors: As specified in SECTION 03 15 05.

2.4 FABRICATION
- A. Shop Assembly:
  1. Post spacing: Maximum 6 foot horizontal spacing.
  2. Railing posts bolted to metal or concrete:
     a. In lieu of field cutting, provide the approved fitting with sufficient post overlap containing provisions for vertical adjustment.
     b. Field fit-up is required.
  3. Free of burrs, nicks, and sharp edges when fabrication is complete.
  4. Welding is not permitted.
- B. Shop/Factory Finishing:
  1. Use the same alloy for a uniform appearance throughout fabrication for the railings.
  2. Handrail and post fittings: Match fittings with the color of the pipe in the handrail.
  3. Sand cast parts are not permitted.
- C. Tolerances:
  1. Shop assemble rails, posts, and formed elbows with a close tolerance for a tight fit.
  2. Fit dowels tightly inside posts.

2.5 FINISHES
- A. Aluminum: Mill finish.

PART 3 EXECUTION

3.1 GENERAL
- A. Provide railing posts longer than needed and field cut to exact dimensions to accommodate vertical variations on the structure.
- B. Install railing with a base that provides ±1/4 inch vertical adjustment inside the base fitting. If adjustment is required in the field and exceeds ±1/4 inch, reduce the post length, not to exceed beyond the bottom of the lowest set-screw or bolt in the base fitting.
- C. Field fabrication of aluminum railing systems is not permitted.
- D. Modification to the structure is not permitted where the handrail is attached.

3.2 INSTALLATION
- A. Assembly and Installation: Perform in accordance with the Manufacturer's recommendations and the approved Shop Drawings.
- B. Protection from Entrapped Water:
  1. For installations subject to high humidity, make provisions to drain water from the railing system.
  2. Posts mounted in concrete, bends, and elbows occurring at low points: Drill weep holes of 1/4 inch diameter at the lowest possible elevations in the plane of the rail, one hole per post or rail.
- C. Expansion Joints:
  1. Maximum intervals of 54 feet on center and at structural joints.
  2. Slip joint with an internal sleeve extending 2 inches beyond each side of the joint; provide a 1/2-inch slip joint gap to allow for expansion.
  3. Fasten to one side using a 3/8 inch diameter set screw at the bottom of the rail or post.
  4. Locate joints within 12 inches of posts.
- D. Setting Posts:
  1. Surface-mounted:
     a. Bolt post baseplate connectors firmly in place.
     b. Shims, wedges, grout, and similar devices for handrail post alignment are not permitted.
- E. Posts and Rails:
  1. Set posts plumb and aligned to within 1/8 inch in 12 feet.
  2. Set rails horizontal or parallel to the slope of steps to within 1/8 inch in 12 feet.
  3. Install posts and rails in the same plane: Remove projections or irregularities and provide a smooth surface continuously along the top rail; use an offset rail on stairs and platforms if required.
  4. Support 1 1/2-inch rails directly above stairway stringers with offset fittings.
- F. Toeboards:
  1. Provide at handrails except where 4 inch or higher concrete curbs are installed or at gates.
  2. Measure in field for length. After handrail post installation, cut and secure to the posts.
  3. Dimensions between the bottom of the toeboard and the walking surface shall not exceed 1/4 inch.
  4. Provide expansion and contraction connections between each post.

3.3 PROTECTION
- A. Prevent corrosion caused from direct contact with dissimilar metals and aluminum and concrete and by coating metal surfaces as specified in SECTION 09 90 00.

3.4 QUALITY CONTROL
- A. Testing Laboratory Services: Perform special inspection for anchors where ICC-ES ESRs require them for anchor strength value used.

3.5 ADJUSTING
- A. Touch up minor scratches and abrasions in coated surfaces to match the factory finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for rough carpentry.

1.2 REFERENCES
- A. American Wood Protection Association (AWPA):
  1. U1 – Use Category System: User Specification for Treated Wood
- B. American Society of Mechanical Engineers (ASME):
  1. B18.2.1 – Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
  2. B18.6.1 – Wood Screws (Inch Series)
- C. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
  3. A 563 – Standard Specification for Carbon and Alloy Steel Nuts
  4. B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  5. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  6. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
  7. F 594 – Standard Specification for Stainless Steel Nuts
  8. F 1667 – Standard Specification for Driven Fasteners: Nails, Spikes, and Staples
- D. Forest Stewardship Council (FSC):
  1. STD-40-004 – Chain of Custody Certification Standard
- E. International Code Council Evaluation Service, Inc. (ICC-ES):
  1. NER-272 – National Evaluation Report Number 272
- F. National Institute of Standards and Technology (NIST):
  1. PS 20 – American Softwood Lumber Standard
- G. Western Wood Products Association (WWPA):
  1. Western Lumber Grading Rules

1.3 SUBMITTALS
- A. Product Data: Data for manufactured products.
- B. Quality Control Submittals:
  1. Certificates of compliance for dimension lumber.
  2. FSC Certification.

1.4 QUALITY ASSURANCE
- A. Lumber Grading Agency: In accordance with NIST PS 20.
- B. Identify lumber and panel products by official grade mark.
- C. Fire retardant treated products shall bear the label of a recognized independent testing laboratory indicating a flame spread index of 25 or less, tested in accordance with ASTM E 84.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store materials a minimum of 6 inches above the ground on framework or blocking and cover with a protective waterproof covering providing for adequate air circulation.
- B. Do not store seasoned or treated materials in a damp location.
- C. Protect the edges and corners of sheet materials from damage.

PART 2 PRODUCTS

2.1 MATERIALS
- A. Lumber:
  1. Grading rules: In accordance with WWPA Western Lumber Grading Rules.
  2. Species: Hem Fir or Douglas Fir-Larch.
  3. Grade: Construction.
  4. Surfacing: S4S.
  5. Maximum moisture content: 19%.
  6. Finger jointed, manufactured using low-emitting, urea formaldehyde-free binders.
  7. In accordance with FSC STD-40-004.
- B. Plywood Panel Products:
  1. Thickness: As shown on the Drawings.
  2. Panel grade: APA rated sheathing.
  3. Exposure:
     a. Exterior applications: Exposure 1.
     b. Interior applications: Exposure 2.

2.2 ACCESSORIES
- A. Fasteners:
  1. Type and size: As required by the conditions of use.
  2. Exterior locations, in ground contact and treated products: Hot-dip galvanized steel, in accordance with ASTM A 153.
     a. Nails, brads, and staples: ASTM F 1667.
     b. Power-driven fasteners: ICC ES NER-272.

c. Wood screws: ASME B18.6.1.
d. Lag bolts: ASME B18.2.1.
e. Bolts: Steel bolts in accordance with ASTM A 307, Grade A; with hex nuts in accordance with ASTM A 563.
f. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
g. Material: SST with bolts and nuts in accordance with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

3. Other interior locations: Carbon steel.

2.3 FABRICATION

A. Preservative Treatment:
1. Treat wood in the following locations:
a. Where in contact with roofing and related flashings.
b. Where in contact with masonry or cementitious materials.
c. Where in contact with the ground.
d. Exterior.
2. Exterior lumber not in contact with the ground: Treat in accordance with AWPA U1 to the requirements of UC3B.
3. Exterior lumber in contact with the ground: Treat in accordance with AWPA U1 to the requirements of UC4A.
4. Treatment chemical: ACQ or PTI; free from arsenic, chromium, and other EPA classified hazardous preservatives.

B. Fire Retardant Treatment:
1. Interior wood: Treat in accordance with AWPA U1 to the requirements of UCFA.
2. Exterior wood: Treat in accordance with AWPA U1 to the requirements of UCFB.

PART 3 EXECUTION

3.1 PREPARATION

A. Obtain measurements and verify dimensions shown on the Shop Drawing details before proceeding with carpentry work, wherever possible.
B. Coordinate the location of furring, nailers, blocking, and similar supports so that the attached Work will comply with the design requirements.

3.2 INSTALLATION

A. Provide blocking, nailers, grounds, furring, and other similar items required to receive and support Work.
B. Set members level, plumb, rigid, and accurately cut and fitted.
C. Use materials of the longest practicable lengths and sizes to minimize jointing. Use materials that are free from warp.
D. Securely attach carpentry work to substrates by anchoring and fastening to support applied loads as required by recognized standards.
E. Install telephone and electrical panel backboards where shown on the Drawings.
F. Fasteners:
1. Furnish and install rough hardware required, such as nails, screws, anchor bolts, and similar devices.
2. Rough hardware shall be of the proper type and size for the use intended and adequate to achieve substantial and positive anchorage.
3. Select fasteners of a size that will not penetrate members and where the opposite side will be exposed to view or will receive finish materials.
4. Make tight connections between members. Install fasteners without splitting the wood, pre-drill as required.

G. Site-Applied Wood Treatment:
1. Site-apply preservative treatment to untreated surfaces exposed during the Work.
2. Treat site-sawn ends in accordance with the Manufacturer's instructions.
3. Allow the preservative to cure prior to erecting members.

END OF SECTION

SECTION 06 11 00
FRAMING AND SHEATHING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for framing and sheathing.
- B. Related Sections:
  1. SECTION 06 10 00 – ROUGH CARPENTRY

1.2 REFERENCES
- A. American Wood Protection Association (AWPA):
  1. U1 – Use Category System: User Specification for Treated Wood
- B. American Society of Mechanical Engineers (ASME):
  1. B18.2.1 – Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
  2. B18.6.1 – Wood Screws (Inch Series)
- C. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  3. A 563 – Standard Specification for Carbon and Alloy Steel Nuts
  4. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
  5. B 633 – Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  6. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  7. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
  8. F 594 – Standard Specification for Stainless Steel Nuts
  9. F 1667 – Standard Specification for Driven Fasteners: Nails, Spikes, and Staples
- D. Forest Stewardship Council (FSC):
  1. STD-40-005 – Requirements for Sourcing FSC Controlled Wood
- E. International Code Council Evaluation Service, Inc. (ICC-ES):
  1. NER-272 – National Evaluation Report Number 272
- F. National Institute of Standards and Technology (NIST):
  1. PS 20 – American Softwood Lumber Standard
- G. National Lumber Grades Authority (NLGA):
  1. Standard Grading Rules for Canadian Lumber
- H. Redwood Inspection Service (RIS):
  1. Standard Specifications for Grades of California Redwood Lumber
- I. Southern Pine Inspection Bureau (SPIB):
  1. Standard Grading Rules for Southern Pine Lumber
- J. West Coast Lumber Inspection Bureau (WCLIB):
  1. Standard No. 17 – Grading Rules for West Coast Lumber
- K. Western Wood Products Association (WWPA):
  1. Western Lumber Grading Rules

1.3 SUBMITTALS
- A. Product Data: Manufacturer's information on framing and sheathing materials and appurtenances.
- B. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Lumber Grading Agency: Certified in accordance with NIST PS 20.
- B. Identify lumber and panel products by the official grade mark.
- C. Fire retardant treated products shall bear the label of a recognized independent testing laboratory indicating a flame spread index of 25 or less, tested in accordance with ASTM E 84.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store materials a minimum of 6 inches above the ground on framework or blocking and protect with a properly vented waterproof covering.
- B. Do not store seasoned or treated materials in a damp location.
- C. Protect edges and corners of sheet materials from damage.

1.6 WARRANTY
- A. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the framing and sheathing system and associated appurtenances against rot and termite damage.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Laminated Veneer:
  1. Boise Cascade Corporation
  2. LP Building Solutions
  3. Weyerhauser Company

B. Pre-fabricated Wood I Joists:
   1. Boise Cascade Corporation
   2. LP Building Solutions
   3. Weyerhauser Company
C. Composite Wood:
   1. AZEK Building Products
   2. CertainTeed Corporation
   3. Trex Company, Inc.
D. Joist Hangers:
   1. Simpson Strong-Tie

2.2 MATERIALS

A. Dimension Lumber:
   1. Grading rules: In accordance with NLGA Standard Grading Rules for Canadian Lumber, RIS Standard Specifications for Grades of California Redwood Lumber, SPIB Standard Grading Rules for Southern Pine Lumber, WCLIB Standard No. 17, or WWPA Western Lumber Grading Rules.
   2. Species: Douglas Fir-Larch or Hem Fir.
   3. Grade: No. 2 or better.
   4. Surfacing: S4S.
   5. Maximum moisture content: 19%.
   6. Finger jointed, manufactured using low-emitting, urea formaldehyde-free binders.
   7. Certified in accordance with FSC STD-40-005.
B. Laminated Veneer Lumber:
   1. Fabricated by laminating wood veneers under pressure using an exterior type adhesive with a grain of veneers parallel with the length.
   2. Veneer: Douglas Fir or Southern Pine.
   3. Manufactured using low-emitting, urea formaldehyde-free binders.
   4. Certified in accordance with FSC STD-40-005.
C. Pre-fabricated Wood I Joists:
   1. Fabricated by bonding stress graded lumber flanges to webs with exterior type adhesive.
   2. Flange material: Joist Manufacturer's standard.
   3. Web material: Joist Manufacturer's standard.
   4. Manufactured using low-emitting, urea formaldehyde-free binders.
   5. Certified in accordance with FSC STD-40-005.
D. Composite Joists and Headers:
   1. Fabricated by laminating wood veneers to a narrow oriented strand board to produce rectangular members with veneers making up no less than 32% of the total cross-section.
   2. Made with low-emitting, urea formaldehyde-free adhesives.
E. Composite Wood:
   1. Extruded product consisting of recycled, PE, and industrial waste wood fibers with integral coloring.
   2. Color: As shown on the Drawings.
F. Panel Products:
   1. Type: APA Plywood.
   2. Panel grade:
      a. Floor, wall, and roof sheathing: APA Rated Sheathing.
      b. Combination subfloor/underlayment: Georgia-Pacific Sturd-I-Floor.
      c. Underlayment: APA Underlayment.
   3. Exposure:
      a. Exterior applications: Exterior – Exposure 1.
      b. Interior applications: Exterior – Exposure 2.
   4. A rapidly renewable product made from chopped straw and manufactured using low-emitting, urea formaldehyde-free binders.
   5. Certified in accordance with FSC STD-40-005.

2.3 ACCESSORIES

A. Fasteners:
   1. Type and size: As required by the conditions of use.
   2. Exterior locations, in ground contact and treated products: Hot-dip galvanized steel, in accordance with ASTM A 153, G90 coating class.
      a. Nails, brads, and staples: ASTM F 1667.
      b. Power-driven fasteners: ICC ES NER-272.
      c. Wood screws: ASME B18.6.1.
      d. Lag bolts: ASME B18.2.1.
      e. Bolts: Steel bolts in accordance with ASTM A 307, Grade A; with hex nuts in accordance with ASTM A 563.
      f. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
      g. Material: SST with bolts and nuts in accordance with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.
   3. Plate connectors or strap anchors: Galvanized steel, die punched to achieve fastener configuration, in accordance with ASTM A 653.

4. Joist hangers: Galvanized steel sized to suit joists and framing conditions.
5. Other interior locations: Carbon steel.

B. Metal Connectors:
1. Galvanized steel, in accordance with ASTM A 653, G185 coating class.
2. The size and shape to suit framing conditions.

C. Subflooring Adhesive:
1. Waterproof, water-based, air cure type, in cartridge dispensers.
2. Maximum VOC content: 30 g/L.

D. Sill Gasket: 1/4 inch thick, plate width, closed-cell PE or urethane foam from continuous rolls.

E. Termite Shield: Galvanized sheet steel, minimum 26 gauge.

2.4 FABRICATION

A. Preservative Treatment:
1. Treat wood in the following locations:
a. In contact with roofing and related flashings.
b. In contact with masonry or cementitious materials.
c. In contact with the ground.
d. Exterior.
2. Interior lumber: Treat in accordance with AWPA U1 to the requirements of UC2.
3. Exterior lumber not in contact with the ground: Treat in accordance with AWPA U1 to the requirements of UC3B.
4. Exterior lumber in contact with the ground: Treat in accordance with AWPA U1 to the requirements of UC4A.
5. Exterior lumber decking and walls in flume structures: Treat in accordance with AWPA U1 to the requirements of UC4B.
6. Exterior lumber used in foundation piling and freshwater piling: Treat in accordance with AWPA U1 to the requirements of UC4C.
7. Treatment chemical: ACQ or PTI; free from arsenic, chromium, and other EPA classified hazardous preservatives.

B. Fire Retardant Treatment:
1. Interior wood: Treat in accordance with AWPA U1 to the requirements of UCFA.
2. Exterior wood: Treat in accordance with AWPA U1 to the requirements of UCFB.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set members level, plumb, rigid, and accurately cut and fitted.

B. Make provisions for erection loads and for temporary bracing to maintain the safety of the structure, plumb, and in true alignment until the completion of the erection and installation of permanent bracing.

C. Place beams, joists, and rafters with the crown edge up.

D. Construct load bearing framing members of full length without splices.

E. Securely attach the Work to substrates by anchoring and fastening to support applied loads as required by recognized standards.

F. Sills:
1. Place full width continuous sill flashings under framed walls on cementitious foundations; lap the flashing joint 4 inches.
2. Place the sill gasket directly on the sill flashing or cementitious foundation; fit the gasket tight to the protruding foundation anchor bolts.
3. Anchor sills to the foundation with anchor bolts, expansion fasteners, or power-driven fasteners as applicable.

G. Joist Framing:
1. Provide a minimum 1 1/2 inches of bearing.
2. Lap members by framing from opposite sides at a minimum of 4 inches.
3. Construct double joist headers at floor and ceiling openings and under wall stud partitions parallel to floor joists. Frame rigidly into joists.
4. For spans larger than of 8 feet, bridge joists at mid-span.

H. Stud Framing:
1. Provide a single bottom plate and double top plates for load bearing partitions.
2. Provide a single bottom plate and top plates for non-load bearing partitions.
3. Anchor bottom plates to the concrete structure with anchor bolts, expansion fasteners, or power-driven fasteners as applicable. Triple studs at corners and at partition intersections.
4. Anchor studs that abut masonry or concrete with toggle or expansion bolts.
5. Frame openings with double studs and headers; space short studs over and under an opening to the stud spacing.
6. If wood sheathing is not installed, provide diagonal one by 4-inch bracing at the corners; notch studs to fit.

I. Rafter Framing:
1. Notch to fit exterior wall top plates.
2. Double the rafters at roof openings and support with steel hangers.
3. At the ridge, place rafters directly opposite each other and secure to a ridge member.
4. At hips and valleys, bevel ends for bearing against the hip or valley rafter.
5. Locate collar ties at every third pair of rafters, 1/3 of the distance to ceiling joists; cut ends to fit the slope and secure to the rafters.

J. Beams:
1. Provide a minimum end bearing of 4 inches.
2. Nail built-up members with two rows of nails spaced 6 inches on center at a maximum.

K. Lumber and Composite Wood Decking:
   1. Place decking to span two or more supports, with the ends occurring over supports.
   2. Stagger end joints in adjacent rows.
   3. Secure to each support with two fasteners.

L. Roof Sheathing:
   1. Place panels perpendicular to framing members with the ends staggered and the sheet ends over firm bearing.
   2. Install sheathing clips between adjacent sheets enclosed by roof framing members if tongue-and-groove panels are not used.
   3. Leave 1/8 inch expansion space at panel ends and edges.
   4. Secure to supports with nails or screws, as applicable, spaced a maximum of 6 inches on center along the edges and a maximum of 12 inches on center in the field of panels.

M. Wall Sheathing:
   1. Place panels parallel or perpendicular to framing members, with ends over firm bearing and staggered.
   2. At corners, place sheathing for a horizontal distance of 48 inches if diagonal corner braces are not installed.
   3. Leave 1/8 inch expansion space at panel ends and edges.
   4. Secure to supports with nails or screws, as applicable, spaced a maximum of 6 inches on center along the edges and a maximum of 12 inches on center in the field of panels.

N. Floor Decking:
   1. Place panels perpendicular to framing members, with the ends over firm bearing and staggered.
   2. Leave 1/8 inch expansion space at panel ends and edges.
   3. Secure to supports with nails or screws spaced a maximum of 12 inches on center along the edges and in the field of panels.

O. Subflooring:
   1. Install flooring underlayment after dust and dirt generating activities have ceased and prior to the application of finished flooring.
   2. Install building felt between floor decking and subflooring.
   3. Apply perpendicular to decking; stagger the joints of underlayment in adjacent rows.
   4. Leave 1/8 inch of expansion space at panel ends and edges.
   5. Secure to supports with adhesive, nails, and screws spaced a maximum of 6 inches on center along edges and a maximum of 12 inches on center in the field of the panels.

P. For blocking, nailers, grounds, furring, and other similar items required to receive and support Work, as specified in SECTION 06 10 00.

Q. Fasteners:
   1. Provide and install hardware required, such as nails, screws, anchor bolts, and similar devices.
   2. Hardware shall be of the proper type and size for the use intended and adequate to achieve substantial and positive anchorage.
   3. Select fasteners of a size that will not penetrate members, and where the opposite side will be exposed to view or will receive finish materials.
   4. Make tight connections between members. Install fasteners without splitting the wood; pre-drill as required.

R. Site-Applied Wood Treatment:
   1. Site-apply preservative treatment on untreated surfaces exposed during construction.
   2. Treat site-sawn ends in accordance with the Manufacturer's instructions.
   3. Allow preservative to cure prior to erecting members.

3.2 QUALITY CONTROL

A. Framing Members: 1/4 inch from true position at a maximum.

B. Surface Flatness of Floor: 1/4 inch in 10 feet at a maximum.

END OF SECTION

SECTION 06 40 00
ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for architectural woodwork.

1.2 REFERENCES
- A. American Wood Protection Association (AWPA):
  1. U1 – Use Category System: User Specification for Treated Wood
- B. Architectural Woodwork Institute (AWI):
  1. Architectural Woodwork Standards
- C. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. E 84 – Standard Test Method for Surface Burning Characteristics of Materials
  3. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

1.3 SUBMITTALS
- A. Shop Drawings:
  1. Include dimensioned plans, sections, elevations, and details of construction including joinery and interface with adjacent Work.
  2. Designate wood species and finishes.
- B. Samples: 6 inch long of each profile.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications: A minimum of 5 years of documented experience in the Work of this Section. Certified under AWI Quality Certification Program if required.
- B. Fire retardant treated products shall bear the label of a recognized independent testing laboratory indicating Class A, Class B, or Class C materials as shown on the Drawings, tested in accordance with ASTM E 84.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver materials until they are needed for installation.
- B. Protect the materials of this section from moisture and damage before, during, and after installation.

1.6 SITE CONDITIONS
- A. Environmental Requirements: The HVAC system shall be complete and operational for a minimum of 7 days prior to the installation of interior trim.
- B. Field Measurements: Take field measurements and establish the dimensions for woodwork prior to fabrication. Conform to the conditions for fit with the finished Work of other trades.
- C. Coordinate the layout and installation of blocking and reinforcement in partitions for the support of casework.

PART 2 PRODUCTS

2.1 MATERIALS
- A. Interior trim shall be as shown on the Drawings.

2.2 ACCESSORIES
- A. Fasteners: Type and size as required by the conditions of use; plain steel for interior use. Exterior locations and treated products: Hot-dip galvanized steel, in accordance with ASTM A 153, G90 coating class or SST, in accordance with ASTM F 593, Type 304 or 316.
- B. Adhesives: Waterproof, water-based type, compatible with trim materials.
- C. Backprime: Clear lacquer sanding sealer.

2.3 FABRICATION
- A. Quality: In accordance with AWI Architectural Woodwork Standards, Section 6, Custom Grade.
- B. Where field fitting is required, provide ample allowance for cutting.
- C. Run trim, except window stools and aprons, with channeled backs.
- D. Shop prepare and identify components for grain matching during site erection.
- E. Finishing:
  1. Exterior trim: Machine sand exposed flat members and square edges.
  2. Interior trim: Machine sand exposed surfaces at the mill. After installation, sand the exposed surfaces smooth.
- F. Preservative Treatment:
  1. Treat wood that is in contact with masonry or cementitious materials.
  2. Interior lumber: Treat in accordance with AWPA U1 to the requirements of UC2.
  3. Exterior lumber not in contact with the ground: Treat in accordance with AWPA U1 to the requirements of UC3B.
  4. Exterior lumber in contact with the ground: Treat in accordance with AWPA U1 to the requirements of Use UC4A.
- G. Fire Retardant Treatment:
  1. Interior wood: Treat in accordance with AWPA U1 to the requirements of UCFA.
  2. Exterior wood: Treat in accordance with AWPA U1 to the requirements of UCFB.

PART 3 EXECUTION

3.1 PREPARATION
- A. Prior to installation, condition the lumber to the average humidity that will prevail after installation.
- B. Verify the adequacy of backing and support framing and substrates.
- C. Backprime wood that is installed against masonry or cementitious materials prior to installation.

3.2 INSTALLATION
- A. Install in accordance with AWI Architectural Woodwork Standards, Section 1700, Custom Grade requirements.
- B. Install in the longest practicable lengths.

C. Set materials and components in place, plumb, straight, and level.
D. Secure Work to anchors, built-in blocking, or directly attach to substrates; do not fasten Work to plaster or gypsum board.
E. Miter ends, corners, intersections, and returns.
F. Scribe to adjacent construction with maximum 1/32 inch gaps.
G. Allowable Tolerances:
    1. Maximum variation in level and plumb: 1/8 inch in 8 feet.
H. Nailing: Blind nail where possible; use fine finishing nails where exposed; set exposed nail heads for filling.
I. Fasten to supporting construction.

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for architectural wood casework.
- B. Related Sections:
  1. SECTION 06 61 16 – SOLID SURFACING FABRICATIONS
  2. SECTION 07 92 00 – JOINT SEALANTS
  3. SECTION 08 80 00 – GLAZING

1.2 REFERENCES
- A. Architectural Woodwork Institute (AWI):
  1. Architectural Woodwork Standards
- B. National Electrical Manufacturers Association (NEMA):
  1. LD-3 – High Pressure Decorative Laminates

1.3 SUBMITTALS
- A. Product Data: Manufacturer's information on hardware components.
- B. Shop Drawings:
  1. Include dimensioned plan, sections, elevations, and details of construction including joinery and interface with adjacent Work.
  2. Designate wood species, finishes, and colors.
- C. Samples:
  1. Laminate: Plastic, 2 inches by 3 inches, showing available colors and finishes.
  2. Each hardware component.
  3. Lumber: 6 inches long.
  4. Panel product: 12 inches by 12 inches.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Certified under AWI Quality Certification Program.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver materials until they are needed for installation.
- B. Protect the materials of this section from moisture and damage before, during, and after installation.

1.6 SITE CONDITIONS
- A. Environmental Requirements: The HVAC system shall be complete and operational for a minimum of 7 days prior to the installation of cabinets.
- B. Field Measurements: Take field measurements and establish dimensions for casework prior to fabrication. Indicate dimensions on the Shop Drawings. Conform to the conditions for fit with the finished Work of other trades.
- C. Coordination: Coordinate the layout and installation of blocking and reinforcement in partitions for the support of casework.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Plastic Laminate:
  1. Formica Corporation
  2. Nevamar Company
  3. Wilsonart International, Inc.

2.2 MATERIALS
- A. Plastic Laminate: In accordance with NEMA LD-3; laminate grades as required by quality standard.
  1. Horizontal surfaces:
     a. Backing sheet: Grade BKH.
     b. Postformed surfaces: Grade HGP.
     c. Acid resisting: Grade A3.
     d. Other surfaces: Grade HGS.
  2. Vertical surfaces:
     a. Backing sheet: Grade BKL.
     b. Cabinet liner: Grade CLS.
     c. Other surfaces: Grade VGP.
  3. Melamine laminate: Grade VGL.
  4. Colors: To be selected from Manufacturer's full color range.
  5. Finish: Matte.

2.3 ACCESSORIES
- A. Solid Surfacing Countertops: As specified in SECTION 06 61 16.
- B. Fasteners: Type and size as required by the conditions of use.
- C. Adhesives: Waterproof, water-based type, compatible with backing and veneer and laminate materials.
- D. Edge Banding: Rigid PVC extrusions, through-color, 3 mm thickness.
- E. Finish Hardware: In accordance with the Contract Documents.
- F. Joint Sealants: As specified in SECTION 07 92 00.
- G. Cabinet Door Glazing: As specified in SECTION 08 80 00.

2.4 FABRICATION

A. Cabinets – Plastic Laminate Finish:
   1. Quality: In accordance with AWI Architectural Woodwork Standards, Section 10, Custom Grade.
   2. Type: Frameless flush overlay.
   3. Semi-exposed surfaces: Melamine laminate.
   4. Fit exposed and semi-exposed panel edges with matching laminate edging.

B. Cabinets – Transparent Finish:
   1. Quality: In accordance with AWI Architectural Woodwork Standards, Section 10, Custom Grade.
   2. Type: Face frame flush overlay.
   3. Semi-exposed surfaces: Wood to match exposed surfaces.
   4. Fit exposed and semi-exposed panel edges with matching wood edging.

C. Plastic Laminate Countertops:
   1. Quality: In accordance with AWI Architectural Woodwork Standards, Section 10, Custom Grade.
   2. Fabricate from the panel product.
   3. Locate end joints centered or symmetrical; join sections with concealed clamp fasteners; locate plastic laminate butt joints a minimum of 2 feet away from sinks.
   4. Provide holes and cutouts for the mounting of sinks, trim, and accessories.
   5. Edge treatment: Match top.

D. Shop assemble for delivery to the Work site in units that are easily handled and permit passage through building openings.

E. Apply edging in one-piece full lengths.

F. Apply plastic laminate in full uninterrupted sheets, fit corners and joints to hairline. Slightly bevel arises. Apply a laminate backing sheet to the reverse side of laminate faced surfaces.

G. Where field fitting is required, provide ample allowance for cutting. Provide trim for scribing and site conditions.

H. Provide cutouts and reinforcement for plumbing, electrical, appliances, and accessories. Prime paint the surfaces of cut edges.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installation, condition the cabinets to the average humidity that will prevail after installation.

B. Verify the adequacy of backing and support framing and substrates.

3.2 INSTALLATION

A. Install in accordance with AWI Architectural Woodwork Standards, Section 10, Custom Grade requirements and approved Shop Drawings.

B. Set materials and components in place, plumb, straight, and level.

C. Secure Work to anchors or built-in blocking or directly attached to substrates; do not fasten Work to plaster or gypsum board.

D. Scribe to adjacent construction with a maximum of 1/32 inch gaps.

E. Allowable Tolerances:
   1. Maximum variation in level and plumb: 1/8 inch in 8 feet.

F. Nailing: Blind nail where possible; use fine finishing nails where exposed; set exposed nail heads for filling.

G. Use concealed fasteners to align and secure adjoining countertops and cabinet units.

H. Fill joints between tops and splashes with sealant; finish flush.

3.3 CLEANING

A. Remove dust, dirt, and saw dust from cabinets and drawers.

B. Clean casework, countertops, shelves, hardware, fittings, and fixtures ready for use.

3.4 ADJUSTING

A. Adjust doors, drawers, and hardware so they are properly aligned.

B. Adjust moving or operating parts to function properly and smoothly.

END OF SECTION

SECTION 06 61 16
SOLID SURFACING FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for solid surfacing fabrications.
- B. Related Sections:
  1. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCE
- A. ASTM International (ASTM):
  1. D 570 – Standard Test Method for Water Absorption of Plastics
  2. D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  3. D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
  4. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  5. G 21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- B. National Electrical Manufactures Association (NEMA):
  1. LD3 – High-Pressure Decorative Laminates
- C. Underwriters Laboratories (UL):
  1. 723 – Test for Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS
- A. Product Data: Indicate product description, fabrication information, and compliance with specified performance requirements.
- B. Shop Drawings: Indicate dimensions, component sizes, fabrication details, attachment provisions, and interface with adjacent Work.
- C. Samples: 2 inch by 2 inch showing available colors.
- D. Closeout Submittal: Maintenance data including the recommended cleaning materials, procedures, and damage repair.

1.4 QUALITY ASSURANCE
- A. Fabricator Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Fire Hazard Classification: A flame spread index rating of 25 maximum, tested in accordance with ASTM E 84 and UL 723.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver materials until they are needed for installation.
- B. Protect materials from moisture and damage before, during, and after installation.

1.6 SITE CONDITIONS
- A. Environmental Requirements: The HVAC system shall be complete and operational for a minimum of 7 days prior to the installation of countertops.
- B. Field Measurements: Take field measurements and establish dimensions for countertops prior to fabrication. Indicate dimensions on the Shop Drawings. Conform to conditions for fit with the finished Work of other trades.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Aristech Surfaces LLC, Avonite Surfaces
- B. DuPont
- C. Formica Corporation
- D. Wilsonart International, Inc.

2.2 MATERIALS
- A. Solid Surfacing:
  1. Corian by DuPont, Formica Solid Surfacing by Formica Corporation.
  2. Material: Homogenous sheet material composed of modified plastic resins, filler materials, and coloring agents.
  3. Thickness: 1/2 inch.
  4. Color: To be selected from the Manufacturer's full color range.
  5. Surface finish: Matte.
- B. Design Criteria:
  1. Impact resistance 1/2 lb: No fracture at a height greater than 144 inches, when tested in accordance with NEMA LD3-3.3.
  2. Hardness: Minimum of 59, when tested in accordance with ASTM D 2583.
  3. Water absorption: Less than 0.25%, when tested in accordance with ASTM D 570.
  4. Tensile modulus: Minimum 1.2×10^6 psi when tested in accordance with ASTM D 790.
  5. Fungal resistance: No growth when tested in accordance with ASTM G 21.
  6. High temperature resistance: No effect, when tested in accordance with NEMA LD3-3.6.
  7. Boiling water resistance: No effect, when tested in accordance with NEMA LD3-3.5.

2.3 ACCESSORIES
- A. Adhesive: The type recommended by the solid surfacing Manufacturer to create inconspicuous non-porous joints.
- B. Joint Sealant: As specified in SECTION 07 92 00.

2.4 FABRICATION
- A. Fabricate components in the shop to the sizes and shapes shown on the Drawings and in accordance with the Manufacturer's instructions and the approved Shop Drawings.

B. Fabricate splashes and skirts from solid surfacing in a color that matches the countertops.
C. Form joints to be inconspicuous in appearance and without voids. Join pieces with adhesive.
D. Provide holes and cutouts for the mounting of sinks, trim, and accessories.
E. Finish exposed edges to a smooth, uniform profile as shown on the Drawings.
F. Allowable Tolerances:
   1. Maximum variation in size: 1/8 inch.
   2. Maximum variation in location of openings: 1/8 inch from the location shown on the Drawings.
   3. Maximum variation in level and plumb: 1/8 inch in 8 feet.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Set plumb, level, and straight.
C. Adhere countertops, splashes, and skirts with beads of adhesive.
D. Seal the perimeter with joint sealant as specified in SECTION 07 92 00. Finish smooth and flush.

3.2 PROTECTION
A. Protect surfaces from damage.

3.3 ADJUSTING
A. Repair minor scratches and abrasions.

END OF SECTION

SECTION 06 80 00
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for fiberglass reinforced plastic fabrications.

B. Related Sections:

1. SECTION 03 15 05 – ANCHORING TO CONCRETE

1.2 REFERENCES

A. ASTM International (ASTM):

1. D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
2. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
3. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

B. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

C. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910 – Occupational Safety and Health Standards

1.3 SUBMITTALS

A. Product Data:

1. Catalog information and catalog data showing materials, design, load, span, and deflection; include the Manufacturer's specifications.
2. Calculations for fabricated items showing dimensions, materials of construction, weight, size, and location, and verifying compliance with the specified design criteria; also include the following data on structural elements:
   a. Section properties.
   b. Flexural, tensile, compressive, and shear strengths.
   c. Weight per foot.
   d. Modulus of elasticity.
3. Test reports:
   a. Test data for handrails and supports may supplement load calculations providing the data covers the complete system, including anchorage.
   b. Test data for components showing load and deflection due to load, in enough detail to prove the handrail is strong enough and satisfies national, state, and local standards, regulations, code requirements, and OSHA 29 CFR 1910, using the design loads specified.
   c. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Post and base connections.
      4) Railing expansion joint connections.
   d. Where NSF/ANSI 61 certified items are required, submit certification for each component, system, and source manufacturing plant from the NSF website: www.nsf.org.

B. Shop Drawings: Detailed Shop Drawings showing plans, elevations, sections, and details of fabrications and connections including:

1. Grating and top plates: Show the location of connections to adjacent grating, supports, and other Work.
2. Grating supports: Show anchorage to the supporting structure.
3. Hatches, stairs, platforms, stringers, handrails, ladders, ladder safety cages, ladder safety poles, and support structures:
   a. Dimensions, weight, size, and location of connections to adjacent supports and other Work.
   b. Structural calculations for hatches, gratings, platforms, ladders and cages, connections, handrails, and other fabrications shown on the Drawings.
   c. Hatches: Method of attaching the hatch cover to the grating such that the cover can be independently removed by hand without the use of tools.

C. Samples: Each type of grating, including grating with bonded top plate, handrail, and handrail connection.

D. Quality Control Submittal: Provide the Manufacturer’s design which has been prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

B. Manufacturer Qualifications: A minimum of 5 years of documented experience in the manufacturing of the products of this Section.

C. Designer Qualifications: Calculations required for CONTRACTOR design shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.

D. Design Requirements:

1. Components and connectors require CONTRACTOR design.
2. Products and fabrications used in contact with treated water: NSF/ANSI 61 certified or coated with NSF/ANSI 61 certified coating system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
   1. Ladders shall be shipped fully shop-fabricated and assembled.
   2. Factory assemble other items into the largest practicable size suitable for transporting.
   3. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect the materials from damage and facilitate identification and final assembly in the field.

B. Storage and Handling: In accordance with the Manufacturer's recommendations and in such a manner as to prevent damage, including overexposure to UV light.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Fibergrate Composite Structures, Inc.

B. Strongwell, Chatfield Division or Bristol Division

2.2 MATERIALS

A. General:
   1. Provide end products from one Manufacturer.
   2. Manufacturing process:
      a. Pultruded process using vinyl ester unless shown as molded process on the Drawings.
      b. Include UV inhibitor additives unless shown as molded process on the Drawings.
   3. Provide a synthetic surface veil covering on exterior surfaces.
   4. Chemical resistance: Ensure that resins used in the fabrication of FRP products are resistant to chemicals in the location where the FRP product will be used.
   5. Fire retardance:
      a. Flame spread: Less than 25 in accordance with ASTM E 84.
      b. Include combinations of aluminum trihydrate, halogen, and antimony trioxide where required to meet fire retardance in the resin system.
      c. Self-extinguishing in accordance with ASTM D 635.
      d. Flame retardance is not required where NSF/ANSI 61 Certification is required.
   6. Finish:
      a. Pigment shall be dispersed in the resin system.
      b. Color: Federal Safety Yellow.
      c. Fabricate FRP products exposed to outdoor conditions with a minimum of 1 mil thick UV coating, in addition to UV inhibitor additives, to shield the product from UV light.
   7. Seal cut ends, holes, and abrasions of FRP shapes with resin to prevent the intrusion of moisture. Resin shall contain UV inhibitor additives.

B. Grating, Grating with Bonded Top Plate, and Stair Treads:
   1. General:
      a. A minimum uniform load of 100 psf.
      b. A minimum concentrated load of 300 lbs.
      c. Maximum deflection: 1/8 inch.
      d. Top plate:
         1) Shop-bonded top plate at the locations shown on the Drawings.
         2) Epoxied, coated anti-skid grit surface.
      e. Stair tread: A 100 psf uniform load or concentrated load of 300 lbs on an area of 4 sq in located in the center of the tread, whichever produces greater stress.
   2. Molded type:
      a. Description: Grating of one-piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane.
      b. Non-skid grit affixed to the top of the bar surface or a concave, meniscus top to the bars, providing skid resistance. A skid-resistant surface is not required for grating at locations where a bonded top plate is used.
      c. Load bars in both directions with equal stiffness.
      d. Square mesh, 1 1/2 inches maximum spacing.
   3. Pultruded type:
      a. Main bars joined by cross bars secured in holes drilled in the main bars.
      b. Cross bars with 6 inches maximum spacing shall mechanically lock main bars in position to prevent movement.
      c. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
      d. Main bar ends: A minimum bearing support width of 1 1/2 inches.
      e. Skid-resistant surface: Grit adhesively bonded, the Manufacturer's standard; a skid-resistant surface is not required for grating at locations where a bonded top plate is used.
      f. Provide extra stiffness around openings.
   4. Hold-down clamps: The same material as the grating or ASTM F 593 Type 316 SST, a minimum of 4 clamps per panel.
   5. Bolts and connectors:
      a. Corrosion-resistant FRP or ASTM F 593 Type 316 SST.
      b. Size and strength to meet the design requirements.

2.3 COMPONENTS

A. Handrail:

1. Structural criteria:
   a. Deflection: No permanent set in member or connection when tested to the design load.
   b. Apply load to produce maximum stress and deflection in each respective component.
   c. Top rail and posts of handrails: Capable of withstanding the following load cases with a safety factor of 3.0:
      1) A concentrated load of 200 lbs applied at any point in any direction.
      2) A uniform load on the top rail of 50 lbs/lf applied horizontally.
      3) The concentrated load need not be assumed to act concurrently with uniform loads.
   d. Mid-rails with corner returns: Withstand a 300 lb concentrated vertical load applied at any point or direction without damage to or loosening of fittings or attachment hardware.
   e. Concrete anchors for handrail wall brackets: Not to exceed allowable loads for actual spacing, edge distance, and embedment, with an assumed concrete strength of 4,000 psi.
   f. Concrete anchors: In accordance with allowable load values for size, length, embedment, spacing, and edge distance to match the required loads shown in the calculations.
   g. Connections, mounts, and bases: Withstand handrail loads without permanent set and with a minimum safety factor of 1.65 against failure.
2. Thermal movement:
   a. Allow for a maximum range of ambient temperature change. Temperature change is the difference between the high or low temperature and the installation temperature.
   b. Base the design calculation on the actual surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
   c. Temperature change range: 70°F, ambient; 100°F, material surfaces.
3. Components:
   a. Glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50% resin-to-glass ratio.
   b. Continuous glass strand rovings shall be used internally for longitudinal strength.
   c. Continuous strand glass mats shall be used internally for transverse strength.
4. Rails and posts:
   a. Posts: 2 inch nominal square or round tubing.
   b. Rails: 1 3/4 inch or 2 inch nominal round or square rails.
   c. Maximum post spacing: 5 feet.
5. Kickplate/toeboard: 4 inch high by 1/2 inch deep by 1/8 inch thickness with two reinforcing corrugations:
   a. Kickplate/toeboard connectors and splices: Continuous with a provision for expansion and contraction without distortion or buckling.
6. Connections, mounts, and bases: Fiberglass or ASTM F 593 Type 316 SST designed for proper loading and usage.

B. Structural Shapes and Platforms:

1. Deflection and safety factors:
   a. Deflection criteria: Not to exceed 1/360 of the span.
   b. Safety factors: Minimum ratios of ultimate stress to allowable static service stress:
      1) Flexural members: 2.5.
      2) Compression members: 3.0.
      3) Shear: 3.0.
      4) Connections: 4.0.
   c. Minimum design safety factors for dynamic or impact loads shall be twice the values for static service loads.
2. Loads:
   a. Uniform live load over platform: 100 psf.
   b. Static and dynamic loads for the equipment shown on the Drawings.

PART 3 EXECUTION

3.1 GENERAL

A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Install plumb, level, rigid, and free of rack.
C. Set accurately in location, alignment, and elevation.
D. Provide fasteners and anchorages for the complete installation. Provide the appropriate type and size of anchorage devices and fasteners for securing fabrications to in-place construction that is adequate to support the anticipated loads. As specified in SECTION 03 15 05.
E. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin.

3.2 INSTALLATION

A. Handrail: Provide and install expansion and contraction connections as shown on the approved Shop Drawings.
B. Grating and Grating with Top Plate:
   1. Anchor grating securely to the supports to prevent displacement.
   2. Install grating sections to be easily removable.
   3. Clearance between grating and vertical surfaces: 1/4 inch, ±1/8 inch.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 11 13
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for bituminous dampproofing.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 1227 – Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
  2. D 1668 – Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing

1.3 SUBMITTALS
- A. Product Data: Include product description and performance characteristics.

1.4 DELIVERY, STORAGE, AND HANDLING
- A. Store materials in an enclosed space protected from weather and direct sunlight.
- B. Maintain a temperature range in the storage area of 40ºF to 90°F.

1.5 SITE CONDITIONS
- A. Do not apply at ambient or surface temperatures below 40°F nor during inclement weather.
- B. Substrate: Cured a minimum of 7 days.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Asphalt Emulsion:
  1. BASF Building Systems (Master Builders), MasterSeal 615
  2. Euclid Chemical, Dehydratine 75
  3. W.R. Meadows, Inc., Sealmastic Emulsion, Type II

2.2 MATERIALS
- A. Cold-Applied, Emulsified-Asphalt Dampproofing:
  1. Type: Water-based, fibered, consisting of refined asphalt and emulsifiers in accordance with ASTM D 1227.
  2. VOC content: 30 g/L or less.

2.3 ACCESSORIES
- A. Emulsified-Asphalt Primer: In accordance with ASTM D 1227, Type III, Class 1, except diluted with water as recommended by the Manufacturer.
- B. Asphalt-Coated Glass Fabric: In accordance with ASTM D 1668, Type I.
- C. Patching Compound: Fibered mastic of the type recommended by the Dampproofing Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION
- A. Clean surfaces to receive dampproofing; remove dust, loose aggregate, debris, oil, grease, and contaminants.
- B. Do not apply damproofing at ambient or surface temperatures below 40ºF or when temperatures are expected to fall to 40ºF within 24 hours.
- C. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.
- D. Fill cracks over 1/4 inch in width with patching compound.
- E. Dampen dry surfaces before applying dampproofing.

3.2 APPLICATION
- A. Apply to buried structures including below grade concrete, brick, and precast concrete structures from 2 inches below finish grade elevation to the top of footings, the bottom of lower level slab, or as shown on the Drawings.
- B. Apply emulsion by brushes and rollers, or spray to a continuous and uniform coverage.
- C. Apply in two coats at a minimum rate of 35 sfpgpc or as recommended by the Manufacturer.
- D. In accordance with the Product Manufacturer's recommendations for drying time between successive coats. Seal items projecting through dampproofing watertight with reinforcing fabric embedded in mastic protection.
- E. Protect bituminous dampproofing in accordance with the Manufacturer's instructions.
- F. Protect damproofing from rain until coating is dry.

3.3 QUALITY CONTROL
- A. Prior to applying veneer, inspect surfaces for voids and damage.
- B. Repair voids and damaged areas with an additional coat of emulsion.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 13 00
SEALING SHEET WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for sealing sheet waterproofing.
- B. Related Sections:
  1. SECTION 03 93 00 – CONCRETE REHABILITATION – REPAIR CONCRETE AND MORTAR

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
  2. C 1583 – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
  3. D 624 – Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
  4. D 638 – Standard Test Method for Tensile Properties of Plastics
  5. D 695 – Standard Test Method for Compressive Properties of Rigid Plastics
  6. D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- B. NSF International/American National Standards Institute (NSF/ANSI):
  1. 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS
- A. Product Data:
  1. The Manufacturer's certification that the proposed materials, details, and systems as shown on the Drawings and specified are in accordance with the Manufacturer's instructions.
  2. The Manufacturer's descriptive literature and product specifications for each product.
  3. Laboratory tests or data to validate product compliance with performance criteria specified.
  4. SDS.
  5. NSF/ANSI 61 Certification.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. Approved by the Manufacturer.
  2. A minimum of five documented projects of a similar nature in the past 5 years or training provided by the Product Manufacturer.
- C. System Requirements:
  1. Coordinate installation Work with Work of other trades.
  2. Provide materials and accessories in a timely manner so as not to delay Work.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver and store in a dry area between 40°F and 95°F.
- B. Handle and protect in accordance with the Manufacturer's instructions.
- C. Deliver materials in the Manufacturer's unopened containers, fully identified with the brand, type, grade, class, and other qualifying information.
- D. Keep products clean, dry, and free of damage.

1.6 SITE CONDITIONS
- A. Condition material at a temperature ranging from 65°F to 85°F for at least 2 days before application.
- B. Do not apply materials to cold surfaces. The minimum surface and ambient air temperatures shall be 40°F.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Waterproofing Sealing System:
  1. Sika Corporation, Sikadur Combiflex
- B. Epoxy Paste Adhesive:
  1. Sika Corporation, Sikadur 31, Hi-Mod Gel

2.2 MATERIALS
- A. Epoxy Paste Adhesive Material:
  1. Color: Gray.
  2. Mixing ratio: 1 to 1 by volume, Component A to Component B.
  3. Consistency: Non-sag paste.
  4. Pot life: Approximately 30 minutes at 73°F.
  5. Tack-free time: 2 hours to 3 hours.
  6. Tensile properties, in accordance with ASTM D 638: 3,300 psi at 7 days.
  7. Flexural properties, in accordance with ASTM D 790: 6,100 psi at 7 days.
  8. Shear strength: 4,600 psi at 7 days.
  9. Bond strength, in accordance with ASTM C 882:
     a. Hardened concrete to hardened concrete: 2,900 psi at 14 day moist cure.
     b. Hardened concrete to steel: 2,900 psf at 14-day moist cure.
  10. Water absorption: 0.07% total in 24 hours.
  11. Compressive strength, in accordance with ASTM D 695: 12,900 psi at 7 days at 40°F.

12. Compressive modulus of elasticity, in accordance with ASTM D 695: 3.9 x 10^5 psi at 7 days.

B. Sealing Sheet:
   1. Modified flexible polyolefin waterproofing tape
   2. Width and length: As shown on the Drawings
      a. Available in 4 inch, 8 inch and 12 inch widths.
      b. Available in 20 feet and 82 feet lengths.
   3. Thickness: 40 mils.
   4. Minimum tensile strength: 1,700 psi.
   5. Minimum elongation at break: 600%.
   6. Tear resistance, ASTM D 624: Die C 69 lb/in.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates, adjoining construction, and conditions under which Work is to be installed.

B. Notify the ENGINEER if negative water pressure is suspected behind the concrete surface to which the sealing sheet waterproofing system is to be installed. Negative water pressure shall be resisted by anchoring steel plates over the joint designed for the assumed negative pressure.

C. Do not proceed with Work until unsatisfactory conditions are corrected and surfaces are properly prepared.

D. Minimize the number of required splices based on joint length and available length of waterproofing tape. One splice will be permitted per 20 feet of sealing sheet installation. Overlap sections of membrane a minimum of 4 inches.

E. Protect adjacent surfaces not designated to receive waterproofing by taping to permit a neat line of gel adhesive application; remove tape prior to the setting of gel adhesive.

F. Substrate Preparation:
   1. New construction:
      a. Remove contaminants by high-pressure water blasting, greater than 3,000 psi, wet or dry sand blasting, or other mechanical means to produce surfaces suitable for the application of the sealing sheet.
      b. Surface characteristics:
         1) Clean and sound.
         2) May be damp but shall be free of standing water and contaminants.
         3) Open textured finish.
   2. Existing construction:
      a. Remove surface deposits and rust by high-pressure water blasting, greater than 3,000 psi, wet or dry sand blasting, or other mechanical means to produce surfaces suitable for the application of waterproofing sealing system.
      b. Protect existing sealant in joint and concrete surfaces outside of the extent of the sealing strip during the process to prevent the loss of sealant and concrete surface.
      c. Use material such as steel to delineate the surface to be blasted.
      d. Surface characteristics:
         1) Clean and sound.
         2) May be damp but shall be free of standing water and contaminants; use fans or other means to dissipate excess condensation and moisture on wall.
         3) Open textured finish.
      e. Tension bond pull testing:
         1) As directed by the ENGINEER, verify the soundness of the concrete substrate by performing two tension-bond pull tests in accordance with ASTM C 1583 per 20 feet of sealing sheet installation.
         2) Remove unsound concrete as determined from these tests and repair flush to the surrounding area as specified in SECTION 03 93 00.

G. Fill bug holes and spalls larger than 1/4 inch in diameter and 1/8 inch deep as specified in SECTION 03 93 00.

H. Adhesive preparation:
   1. Pre-mix each component of gel adhesive.
   2. Proportion one part Component B to one part Component A by volume into a clean pail.
   3. Use calibrated measuring devices, one for each component to ensure volume measurements.
   4. Mix thoroughly for 3 minutes using a Sika paddle on a low-speed drill (400 to 600 rpm) until uniform in color.

3.2 INSTALLATION

A. Temperature of substrate and air shall be as specified in this Section.

B. Wipe membrane clean of any foreign contaminants.

C. Apply mixed adhesive, 1 1/2 inches on each side of the joint to a thickness of at least 1/32 inch.
   1. Work into substrate for proper adhesion.
   2. Set sheeting into gel adhesive.
   3. Using a hard roller, force membrane into gel adhesive.
   4. Apply at least a 1/32 inch thick layer of gel adhesive as a top coat to the sealing sheet in accordance with the Manufacturer's instructions.
   5. Maximum application thickness of gel adhesive: 1/8 inch.
   6. One splice is permitted in the sealing sheet per joint.
      a. Lap membrane a minimum of 4 inches.
      b. The sealing sheet splice shall be bonded together thermally with a hand-welding tool, such as a Leister heat welder, or by activator in accordance with the Manufacturer's instructions.

D. Install steel plate over the sealing sheet system, if required for resisting negative pressure, as shown on the Drawings.

3.3 CLEANING

A. In case of spills or leaks:
   1. Wear suitable protective equipment, contain the spill, and collect with absorbent materials.
   2. Ventilate the area.
   3. Avoid contact.
   4. Properly dispose of cleanup materials in accordance with applicable regulations.

B. Remove left over materials and foreign material from the site.

C. Clean adjacent surfaces and materials.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 13 13
SELF-ADHERING SHEET WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for self-adhering sheet waterproofing.
- B. Related Sections:
  1. SECTION 03 62 00 – NON-SHRINK GROUTING
  2. SECTION 07 11 13 – BITUMINOUS DAMPPROOFING
  3. SECTION 07 92 00 – JOINT SEALANTS
  4. SECTION 31 05 20 – GEOCOMPOSITE DRAINAGE SYSTEM

1.2 REFERENCES
- A. National Roofing Contractors Association (NRCA):
  1. Waterproofing Manual

1.3 PRE-INSTALLATION MEETINGS:
- A. Convene at the site 2 weeks prior to beginning the Work of this Section.
- B. Attendance: ENGINEER, CONTRACTOR, Waterproofing Applicator, Waterproofing Manufacturer's Representative, and related trades.
- C. Review and Discuss: Contract Documents, Waterproofing System Manufacturer's literature, job conditions, scheduling, and other matters affecting the application as appropriate.
- D. Tour representative areas of waterproofing substrates and discuss substrate construction, related items, site conditions, and materials compatibility.

1.4 SUBMITTALS
- A. Product Data: Manufacturer's data for sheet waterproofing and ancillary materials including the product description and performance characteristics.
- B. Shop Drawings: Indicating proposed membrane coverage for vaults, holding tanks, and other structures; show overlap, primers, protection board, and associated methods and materials. Include termination details and interface with adjacent construction.
- C. Quality Control Submittals:
  1. The Manufacturer’s application instructions for materials, include the SDS.
  2. The Manufacturer’s certificate of compliance.
  3. Statement of Qualification: Bituminous Installer.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.5 QUALITY ASSURANCE
- A. Applicator Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Licensed or certified by the Waterproofing Manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store materials on pallets in an enclosed space protected from weather and direct sunlight.
- B. Maintain a temperature range in the storage area between 40˚F and 90˚F. Maintain adequate ventilation of the stored product.
- C. Avoid the use of products containing tars, solvents, pitches, polysulfide polymers, or PVC materials that may come in contact with the membrane.

1.7 SITE CONDITIONS
- A. Environmental Requirements:
  1. Weather: Do not apply materials in rain or snow or within 3 days after surfaces become wet from rainfall or other moisture.
  2. Temperature:
     a. Proceed with work only when existing and forecasted weather conditions will permit work to be performed in accordance with the Manufacturer’s application instructions.
     b. Do not apply materials when ambient temperature is below 40˚F unless using a product designed for a lower temperature application.
  3. Prohibit flames, sparks, welding, and smoking during application.
- B. Concrete Substrates:
  1. Cured for a minimum of 7 days for normal structural concrete; 14 days for lightweight structural concrete unless otherwise permitted by the Manufacturer.
  2. Curing agents containing wax, oil, or pigment shall not be used.
  3. Form-release agents shall be the self-dissipating type.
  4. Surface shall be dry, frost-free with a smooth surface.

1.8 WARRANTY
- A. Manufacturer: Warranty for 5 years from the Substantial Completion date for the satisfactory performance and installation of the waterproofing membrane system and associated appurtenances, including coverage against water leakage through the waterproofing system.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Self-adhering Sheet Waterproofing Membrane:
   1. Carlisle Coatings and Waterproofing (CCW): MiraDri 860/861
   2. GCP Applied Technologies: Bituthene 3000 Membrane, Bituthene Low Temperature Membrane
   3. Polyguard Products, Inc.: Underseal PRM (Puncture Resistant Membrane)
   4. Tamko Building Products LLC: TW-60
   5. W.R. Meadows, Inc SEALTIGHT.: MEL-ROL, MEL-ROL LOW TEMP, MEL-ROL XLT

2.2 MATERIALS

A. Waterproofing Membrane: Self-adhering sheet membrane consisting of rubberized asphalt laminated to PE film, minimum total thickness of 60 mils.

2.3 ACCESSORIES

A. Waterproofing Ancillary Materials:
   1. Primers, adhesives, mastic, liquid membrane, termination bar: The Manufacturer's standard products.
   2. Protection Board: The Waterproofing Manufacturer's recommended product.
   3. Drainage Board (if required): As specified in SECTION 31 05 20 and the Manufacturer's recommendations.

B. Patching Compound: As specified in SECTION 03 62 00, pre-mixed, latex-modified portland cement grout.

C. Joint Sealants: As specified in SECTION 07 92 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Concrete Substrate Preparation:
   1. Remove protrusions flush with adjacent surface.
   2. Remove loose and spalled concrete.
   3. Fill cracks, voids larger than 1/2 inch in any direction, imperfections, and honeycombs with mortar to provide a sound surface for waterproofing.
   4. Clean surfaces to remove dust, loose aggregate, debris, oil, grease, efflorescence, and other foreign materials in accordance with the Manufacturer's instructions.
   5. Allow 3 days of drying time following the washing down of substrate surfaces.
   6. Verify compatibility of dampproofing material as specified in SECTION 07 11 13.

B. Dynamic Cracks and Joints:
   1. Remove loose and spalled concrete.
   2. Patch holes and depressions with patching compound.
   3. Rout out the crack or the joint to the minimum dimensions of 1/4 inch deep by 1/2 inch wide.
   4. Apply sealant to the prepared cracks and joints as specified in SECTION 07 92 00.

3.2 INSTALLATION

A. Apply to roof, top, and sides of slabs, hatches, and a minimum of 3 feet down the sides of buried structures including below-grade concrete, brick, and precast concrete structures, or as shown on the Drawings.

B. Waterproofing:
   1. Prime surfaces and apply membrane to horizontal surfaces, vault roof, and vertical surfaces in accordance with the Manufacturer's recommendations.
   2. Install the waterproofing system in accordance with the Manufacturer's instructions and the NRCA Waterproofing Manual.
   3. Apply primer to the coverage rate required by the Manufacturer.
      a. Allow the primer to dry until it is tack free.
      b. Cover only the area to be covered with membrane in the same day.
      c. Reapply if left uncovered for more than 1 day.
   4. Schedule: Apply waterproofing membrane to the entire area, up vertical access collars to 6 inches above grade, and down walls a minimum of 3 feet, or as shown on the Drawings.
   5. Form a 3/4-inch fillet with liquid membrane on the inside corners; extend a minimum of 6 inches on both sides of the corner at a minimum of 90 mils thick.
   6. Cover static cracks and joints in the substrate with a minimum 9 inch wide membrane strip.
   7. Cover dynamic cracks and joints with a minimum 8 inch wide membrane strip applied in reverse, with the release paper left in place to form a bond breaker. Then, cover with an 18 inch wide strip placed in a normal manner.
   8. Cover inside and outside corners with a minimum 12 inch wide membrane centered over the corner.
   9. Apply the membrane with a minimum 2 1/2 inch side and 5-inch end laps; roll the surface to eliminate wrinkles and air spaces.
   10. Lap the top edge of the membrane over the top of the wall. Terminate the top edge of the wall membrane at grade and seal with a bead of mastic.
   11. Terminate the bottom edge of the membrane within 1 inch of the bottom of the wall and seal the edge with a trowel bead of mastic.
   12. Apply the membrane on horizontal surfaces starting at the low point, laying the membrane perpendicular to slope. Overlap joints as recommended by the Manufacturer.
   13. Provide a double membrane layer a minimum of 6 inches around penetrations and seal with mastic.
   14. If the application is not complete at the end of the workday, seal the exposed edges with mastic.

C. Drainage Board (if required):
   1. Apply drainage board the same day the membrane is applied.
   2. Install in accordance with the Manufacturer's instructions.

3. Cut pieces from roll to required length. Cut to fit around penetrations and at the perimeter.
4. Secure sheets to the waterproofing membrane with adhesive. Place with the filter fabric to the earth.
5. Overlap and secure filter fabric on adjacent sheets.

D. Protection Board:
1. Apply protection board the same day the membrane is applied.
2. Install in accordance with the Manufacturer's instructions.
3. Apply adhesive at the rates recommended by the Manufacturer. Set boards in adhesive with edges butted.
4. Complete backfilling as soon as possible after the application of protection board, within 7 days at a maximum.

3.3 QUALITY CONTROL

A. Inspect the membrane and repair all damaged areas, tears, and inadequate overlaps as recommended by the Manufacturer prior to covering.

B. Horizontal Applications:
1. Dam areas and flood with a minimum of 1 inch of water prior to applying the protection course.
2. After 1 day, check for leaks. If leaks are encountered, repair and repeat the test.
3. When proven watertight, drain the water and remove the dams.

3.4 CLEANING

A. Clean spillage and overspray from adjacent surfaces as recommended by the Manufacturer.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 16 00
FLEXIBLE CEMENTITIOUS WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for flexible cementitious waterproofing.
- B. Related Sections:
  1. SECTION 03 93 00 – CONCRETE REHABILITATION – REPAIR CONCRETE AND MORTAR

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens)
  2. C 348 – Standard Test Method for Flexural Strength of Hydraulic Cement Mortars
  3. D 2240 – Standard Test Method for Rubber Property – Durometer Hardness

1.3 SUBMITTALS
- A. Product Data:
  1. The Manufacturer's certification that proposed materials, details, and systems as shown on the Drawings and specified are in accordance with the Manufacturer's instructions.
  2. If any portion of the Contract Documents does not conform to the Manufacturer's instructions, submit notification to the ENGINEER.
  3. Manufacturer's descriptive literature and product specifications for each product.
  4. Laboratory tests or data that validate product compliance with the performance criteria specified.
  5. SDS.
- B. Warranty Documentation:
  1. Sample warranty.
  2. Installation warranty.
  3. Warranty.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. Approved by the Manufacturer.
  2. A minimum of five documented projects of a similar nature in the past 5 years and training provided by the product Manufacturer.
- C. System Requirements:
  1. Coordinate installation Work with the Work of other trades.
  2. Provide materials and accessories in a timely manner so as not to delay Work.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver and store in a dry area between 40°F and 90°F.
- B. Handle and protect from freezing and direct sunlight in accordance with the Manufacturer's instructions.
- C. Deliver materials in the Manufacturer's unopened containers, fully identified with brand, type, grade, class, and other qualifying information.
- D. Keep products clean, dry, and free of damage.

1.6 SITE CONDITIONS
- A. Maintain the surfaces to be coated and the surrounding air temperature at no less than 40°F for at least 2 days before, during, and after the application of waterproofing.
- B. Do not apply materials to frozen or frost-filled surfaces.
- C. Exercise caution when temperatures exceed 90°F due to rapid set times.

1.7 WARRANTY
- A. Manufacturer: Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the flexible cementitious waterproofing system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Waterproofing Material:
  1. AQUAFIN, Inc., 2K/M
- B. Patching Compound:
  1. Euclid Chemical Company, Vandex Uni Mortar 1 ZSR
- C. Expansion Joint and Crack Sealing Tape:
  1. AQUAFIN, Inc., Joint Sealing Tape-2000S

2.2 MATERIALS
- A. Waterproofing Material: Acrylic modified cement waterproofing; cementitious, two-component, acrylic emulsion based, highly-flexible, crack-bridging waterproof barrier.

2.3 ACCESSORIES
- A. Patching Compound:
  1. Ready-mixed, non-polymer, cementitious waterproofing and repair mortar in accordance with the Waterproofing Manufacturer’s instructions for patching, honeycombs, seal strips (coves, reglets), etc.
  2. Color: Gray.
  3. Aggregate: Powder.

4. Compressive strength: 600 psi at 28 days tested in accordance with ASTM C 109.
5. Flexural strength: 700 psi at 28 days tested in accordance with ASTM C 348.

B. Expansion Joint and Crack Sealing Tape:
1. Elastomeric, tear-resistant, breathable waterproofing tape.
2. Width: 4 3/4 inches or 8 inches.
3. Elongation: 600%.
4. Tear resistance: 2,175 psi tested in accordance with ASTM D 2240.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates, adjoining construction, and conditions under which Work is to be installed.
B. Do not proceed with Work until unsatisfactory conditions are corrected and surfaces are properly prepared.
C. Protect adjacent surfaces that are not designated to receive waterproofing.
D. Substrate Preparation:
1. New construction:
a. Remove contaminants by high-pressure water blasting, greater than 3,000 psi, wet or dry sand blasting, or other mechanical means to produce surfaces suitable for the application of material.
b. Surface characteristics:
1) Clean and sound.
2) May be damp but shall be free of standing water and contaminants.
3) Open textured finish.
2. Existing construction:
a. Remove surface deposits and rust by high-pressure water blasting, greater than 3,000 psi, wet or dry sand blasting, or other mechanical means to produce surfaces suitable for the application of material.
b. Protect existing sealant in the joint and the wall concrete outside of the extent of the sealing strip during the process to prevent the loss of sealant and concrete surface.
c. Use material such as steel to delineate the surface to be blasted.
d. Surface characteristics:
1) Clean and sound.
2) May be damp but shall be free of standing water and contaminants; use fans or other means to dissipate excess condensation and moisture on wall.
3) Open textured finish.
E. Rinse surfaces to be waterproofed with clean water to SSD condition, with no standing water on horizontal surfaces.
F. Fill bug holes less than 1/4 inch wide and 1/8 inch deep with scratch coat of AQUAFIN 2K/M.
G. Fill holes and spalls larger than 1/4 inch wide and 1/8 inch deep as specified in SECTION 03 93 00.

3.2 INSTALLATION

A. Mix waterproofing material in proportions that are in accordance with the Manufacturer’s instructions.
B. Apply waterproofing material in quantities that are in accordance with the Manufacturer's instructions.
1. Apply the first coat of material at 60 mils thickness.
2. Extend the coat 3/4 inches beyond the width of tape.
3. Make the edge neat and straight; use bond breaker to make a neat straight line.
4. Using a steel trowel, embed elastomeric tape uniformly into the first coat of material leaving no wrinkles.
5. Apply the second coat at 30 mils thickness over elastomeric tape as soon as the first coat has sufficiently hardened or wait until the next day.
6. Apply material using a SST trowel.
7. One splice is permitted in the tape per joint.
8. Lap tape a minimum of 6 inches.
C. Curing: Follow the Manufacturer's instructions for the curing and hardening of waterproofing material.

3.3 CLEANING

A. Properly dispose of leftover materials and any foreign material in accordance with applicable regulations.
B. Clean adjacent surfaces and materials.

END OF SECTION

SECTION 07 19 00
WATER REPELLENTS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for water repellents.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 2369 – Standard Test Method for Volatile Content of Coatings
  2. D 3278 – Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
- B. Environmental Protection Agency (EPA):
  1. 40 CFR Part 59, Subpart D – National Volatile Organic Compound Emission Standards for Architectural Coatings
- C. International Union of Laboratories and Experts in Construction Materials, Systems, and Structures (RILEM):
  1. Test Method 11.4 – Measurement of Water Absorption Under Low Pressure

1.3 PRE-INSTALLATION MEETINGS:
- A. Convene at the site 2 weeks prior to beginning the Work of this Section.
- B. Attendance: ENGINEER, CONTRACTOR, Manufacturer's Representative, and Installer.
- C. Review the Manufacturer's requirements for coverage and proper application procedures.

1.4 SUBMITTALS
- A. Product Data: Include the product description and the performance characteristics.

1.5 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Testing:
  1. Conduct a coverage rate test on the masonry mockup panel or the wall area designated to determine the actual final coverage rates.
  2. The coverage rate test shall follow the Manufacturer's recommendations.
  3. Conduct a tube type test in accordance with RILEM Test Method 11.4.
     a. Conduct three tests on untreated substrate, one at each material, to create a baseline to compare against the test on treated walls.
     b. Conduct three tests on treated walls, one at each material.
     c. Compare the time and amount of water draining out of the RILEM tube on the treated and untreated substrate.
     d. The treated wall shall pass RILEM test for wind driven rain at 60 mph.
  4. Reapply and conduct additional tests to determine the revised coverage rate if any of the initial tests fail to meet the specifications.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store materials in an enclosed space protected from weather and direct sunlight.
- B. Maintain a temperature range in the storage area of 40°F to 90°F.

1.7 SITE CONDITIONS
- A. Allow substrate cleaner to dry for a minimum of 2 days prior to application.
- B. Substrate: Cured for a minimum of 28 days.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. ProSoCo, Inc., Blok-Guard and Graffiti Control

2.2 MATERIALS
- A. Clear Water Repellent:
  1. Type: Clear solvent-based, silicone elastomer.
  2. Total solids content: 9%, in accordance with ASTM D 2369.
  3. Specific gravity: 0.802.
  4. VOC content: In accordance with EPA 40 CFR 59.403 AIM VOC regulations.
  5. Density: 6.67 lb/gal.
  6. Flash point: Greater than 100°F, in accordance with ASTM D 3278.

PART 3 EXECUTION

3.1 PREPARATION
- A. Clean the surfaces to receive the repellent; remove dust, loose aggregate, debris, oil, grease, and contaminants.
- B. Do not apply water repellent at temperatures below 40ºF or above 90ºF, or when temperatures are expected to vary from that range within 24 hours or during inclement weather.
- C. Tuck-point cracks and holes over 1/32-inch in width.
- D. Fill cracks over 1/4-inch in width with a patching compound.
- E. Surfaces shall be completely clean, dry, and absorbent before applying water repellent.

3.2 APPLICATION
- A. Apply water repellent using low-pressure airless spray equipment, maximum 20 psi, to a continuous and uniform coverage.
- B. Apply in one coat at the rate established in the test procedure.
- C. Apply from the bottom up with total saturation, wet-on-wet spraying, providing a 6 inch to 8 inch run down.
- D. Avoid excessive overlapping of repellent.
- E. Immediately brush out runs or drips to prevent buildup.

3.3 QUALITY CONTROL

A. Post-installation Testing:

1. Provide the testing required in this Section to the completed Work to ensure compliance with the warranty requirements.
2. Provide two tests at each building, located as directed.

B. Recoat and retest until the proper coating coverage achieves the Manufacturer’s requirements.

3.4 CLEANING

A. Clean adjacent surfaces that are not scheduled to receive water repellent.

B. Strictly follow the Manufacturer's recommendation for cleaning if the water repellent comes in contact with materials adjacent to the Work.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for thermal insulation.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 272 – Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
  2. C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
  3. C 578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
  4. C 665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
  5. D 1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
  6. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS
- A. Product Data: For rigid board insulation, batt insulation, glass fiber insulation, and accessories specified.
- B. Quality Control Submittals: Provide certification from an independent testing laboratory that insulation meets fire hazard classification requirements.

1.4 QUALITY ASSURANCE
- A. Fire Hazard Classification:
  1. Rigid insulation: Classified by UL.
  2. Batt insulation: Flame spread rating of 75 or less, tested in accordance with ASTM E 84.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store insulation in a clean, dry, sheltered area, off the ground or floor until used. Protect against wetting and moisture absorption.

1.6 SITE CONDITIONS
- A. Do not install insulation until the building is substantially watertight and weathertight.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Rigid Board Insulation:
  1. DuPont Company, Styrofoam Brand Square Edge
  2. Owens Corning, Foamular 250
- B. Batt Insulation:
  1. Johns Manville
  2. Knauf Insulation
  3. Owens Corning
- C. Adhesive:
  1. BASF Building System (Master Builders), MasterWeld 948
  2. Henkel Corporation, Loctite PL300

2.2 MATERIALS
- A. Rigid Board Insulation:
  1. Type: Type IV, closed-cell extruded polystyrene, in accordance with ASTM C 578.
  2. Density: 1.6 pcf minimum.
  3. Compressive strength: 25 psi, in accordance with ASTM D 1621.
  4. Thermal resistance: 180 day minimum aged R-values of 5.4 and 5.0 min., °F-ft^2-h/Btu^2/inch at 40°F and 75°F respectively, in accordance with ASTM C 518.
  5. Water adsorption: Maximum 0.3% by volume, in accordance with ASTM C 272.
  6. Thickness: 2 inches.
- B. Batt Insulation:
  1. Type: Glass fiber composition with reinforced kraft paper vapor barrier on one side, in accordance with ASTM C 665, Type II, Class C.
  2. Type: Glass fiber composition with aluminum foil vapor barrier on one side, in accordance with ASTM C 665, Type III, Class C.
- C. Fire Rated Foil Faced Glass Fiber Insulation:
  1. Type: Glass fiber composition with aluminum foil vapor barrier on one side, in accordance with ASTM C 665, Type III, Class A.
  2. Free from urea-formaldehyde resins.
  3. Recycled content: Minimum 25%, with minimum 18% classified as post-consumer.

2.3 ACCESSORIES
- A. Adhesive: The type recommended by the Insulation Manufacturer.
- B. Tape: Minimum of 2 inches wide, pressure-sensitive, waterproof, as recommended for the type of insulation installed.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Rigid Insulation:
  1. Clean the surface of the foundation walls of foreign material that would keep insulation from fitting snug to the foundation wall.

2. Vertical insulation:
    a. Apply insulation boards to the face of exterior foundation walls as shown on the Drawings.
    b. Extend insulation at least 24 inches down from immediately under floor slabs-on-grade.
    c. Adhere insulation to the wall by applying 2 inch diameter spots of adhesive to insulation boards 16 inches on center both ways.
    d. Tightly fit end joints.
    e. Trim insulation so the top of the insulation board terminates 2 inches to 4 inches below finish grade.
3. Horizontal insulation:
    a. Apply insulation boards under and in contact with the floor slab-on-grade where vertical perimeter insulation is not feasible and elsewhere as shown on the Drawings.
    b. Extend insulation 24 inches in from the exterior wall.
    c. Install insulation so it is firmly supported with edges in moderate contact.
4. Cut insulation to fit snugly around pilasters, projections, curves, and irregularities on the wall surface.

B. Batt Insulation:
1. Friction fit between or staple kraft faced batts to wood framing members.
2. Butt insulation to adjacent construction. Butt ends and edges.
3. Carry insulation around pipes, wiring, boxes, and other components.
4. Ensure the complete enclosure of spaces without voids.
5. Apply with a vapor barrier facing towards the interior of the structure.
6. Tape seal lapped flanges, butt ends, tears, and holes in facings.

END OF SECTION

SECTION 07 22 00
ROOF AND DECK INSULATION

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for roof and deck insulation.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
  2. E 108 – Standard Test Methods for Fire Tests of Roof Coverings
- B. Federal Specifications (FS):
  1. HH-I-1972/GEN – Insulation Board, Thermal, Faced, Polyurethane Or Polyisocyanurate
  2. HH-I-1972/2 – Insulation Board, Thermal, Polyurethane Or Polyisocyanurate Faced With Asphalt/Organic Felt, Asphalt/Asbestos Felt Or Asphalt/Glass Fiber Felt On Both Sides Of The Foam
- C. National Roofing Contractors Association (NRCA):
  1. General Guide to Fasteners
- D. Underwriters Laboratories (UL):
  1. 790 – Standard Test Methods for Fire Tests of Roof Coverings
- E. Underwriters Laboratories of Canada (CAN/ULC):
  1. S770 – Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams

1.3 DEFINITIONS
- A. Ponding: Water that remains on roof surface longer than 2 days after termination of the most recent rain event.

1.4 SUBMITTALS
- A. Product Data: Manufacturer's literature highlighting the specifics that show conformance with the Contract Documents.
- B. Shop Drawings: For insulation layout, indicate insulation types, slopes, and thicknesses.

1.5 QUALITY ASSURANCE
- A. Roof Insulation: In accordance with ASTM C 1289, approved for UL Class A rating in accordance with ASTM E 108 or UL 790.
- B. Polyisocyanurate Insulation: In accordance with FS HH-I-1972/GEN and FS HH-I-1972/2.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials in the Manufacturer's original, unopened protective packaging. Store off the ground.
- B. Keep insulation materials dry at all times.
- C. If stored outside, raise insulation above the ground or roof, make level on pallets, and cover with a tarpaulin or other waterproof material. Plastic wrapping installed at the factory shall not be used as an outside storage cover.

1.7 SITE CONDITIONS
- A. Verify that surfaces are in suitable condition. Correct unsuitable surfaces.
- B. Do not lay more insulation than can be completely covered with roofing materials in the same day.
- C. Do not lay insulation on a roof surface that has ponded water, snow, or ice.
- D. Do not expose insulation to excessive heat, sparks, or open flame.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Polyisocyanurate Foam Insulation:
  1. Atlas Roofing Corporation
  2. Carlisle SynTec Systems
  3. Firestone Building Products Company
  4. Johns Manville
- B. Fasteners and Adhesives:
  1. Carlisle Coatings and Waterproofing
  2. Firestone Building Products Company
  3. Johns Manville

2.2 MATERIALS
- A. Rigid Insulation:
  1. Type: Rigid polyisocyanurate faced both sides with glass fiber mat facings, in accordance with ASTM C 1289, Type II, Class 1.
  2. Install boards no thicker than 1 1/2 inches. If the insulation package required is thicker than 1 1/2 inches, install in multiple layers.
  3. Tapered insulation: Provide board tapered to 1/4 in/ft.
  4. Crickets: Provide board tapered to 1/2 in/ft.
  5. Roof insulation shall be compatible with the membrane roofing and an approved product of the roofing membrane Manufacturer.
  6. Insulation fasteners: The type and size as required and provided by the Roof Membrane Manufacturer for the roofing system and the warranty to be provided.
  7. Tapered and non-tapered insulation R-value – minimum conditioned thermal value: 1 inch thickness = R-value of 5.7 as determined in accordance with CAN/ULC S770.
  8. Slope: As shown on the Drawings; provide a combination of cricket and tapered insulation as required to provide an overall 1/4 in/ft of slope.

2.3 ACCESSORIES

A. Fasteners: Corrosion-resistant fasteners with a minimum 3-inch round stress plate, length as required and approved for specific use by the Roofing Manufacturer, and in accordance with the NRCA General Guide to Fasteners.
B. Adhesives: Polyurethane adhesive of the type as required and approved for specific use by the Roofing Manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify that substrate is firm, dry, and clean. For adhesive installation, prepare substrate in accordance with the Manufacturer's instructions.
B. Apply insulation in strict accordance with the Manufacturer's recommendations.
C. Install insulation adhesive using the installation methods and coverage rate outlined in the Manufacturer's instructions and in accordance with specified wind uplift requirements.
D. Mechanically fasten insulation in accordance with specified wind uplift requirements in the Manufacturer's recommended fastening pattern .
E. Install cricket and tapered insulation in layout and geometry to provide a 1/4 inch per foot minimum slope.
F. Cut and fit insulation board around roof penetrations and projections. Feather insulation board around roof drain sumps.
G. Insulation shall only be placed on the surface to be roofed that can be covered with roofing membrane prior to the onset of inclement weather or at the termination of each day's Work.
H. Surfaces and edges of insulation shall not be left exposed at any time. Remove and replace installed insulation that becomes wet.
I. Protect insulation from water at temporary terminations during installation by a suitable cut-off or water dam. Protect applied insulation and completed roofing against damage by roof traffic at all times.
J. Apply units of insulation with long joints continuous. Stagger end joints. Joints shall be tightly butted.
K. In applications of more than one layer, apply with the joints of each succeeding layer staggered from the joints of the previous layer a minimum of 6 inches in each direction.
L. Unless otherwise shown on the Drawings, provide cricket insulation at the high side of rooftop equipment, penetrations, and walls to ensure positive drainage around these elements.
M. Remove, reinstall, or repair the roof system at any area that is ponding or causing ponding.

3.2 QUALITY CONTROL

A. Examine substrates to which construction attaches or abuts with the installer present for compliance with the requirements for installation tolerances and other conditions affecting the performance of the construction of the Work.
B. Report conditions that are contrary to the contract requirements that would prevent proper installation. Do not proceed with installation until unsatisfactory conditions are corrected.
C. Failure to call attention to defects or imperfections will be construed as acceptance and approval of substrate conditions. Installation indicates the acceptance of substrates with regard to conditions that exist at the time of installation and full responsibility for completed Work.

END OF SECTION

SECTION 07 31 13
ASPHALT SHINGLES

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for asphalt shingles.
- B. Related Sections:
  1. SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
  2. D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
  3. D 1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  4. D 3018 – Standard Specification for Class A Asphalt Shingles Surfaced with Mineral Granules
  5. D 3161 – Standard Test Method for Wind-Resistance of Steep Slope Roofing Products (Fan-Induced Method)
  6. D 3462 – Standard Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules
  7. D 3909 – Standard Specification for Asphalt Roll Roofing (Glass Felt) Surfaced With Mineral Granules
  8. D 4586 – Standard Specification for Asphalt Roof Cement, Asbestos Free
  9. D 7158 – Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)
  10. E 108 – Standard Test Methods for Fire Tests of Roof Coverings
- B. National Roofing Contractors Association (NRCA):
  1. Steep-Slope Roof Systems Manual
- C. Underwriters Laboratories (UL):
  1. 790 – Standard Test Methods for Fire Tests of Roof Coverings
  2. 2218 – Standard for Impact Resistance of Prepared Rood Covering Materials

1.3 SUBMITTALS
- A. Product Data: Manufacturer's product description, including construction details, component dimensions, profiles, and textures.
- B. Samples: Shingle samples showing available colors.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Shingles:
  1. Wind uplift resistance: Tested in accordance with ASTM D 3161, Class F and ASTM D 7158, Class H.
  2. Fire hazard classification Class A tested in accordance with UL 790 and ASTM E 108 where products with a fire-test-response classification are specified.
- C. Perform Work in accordance with NRCA Steep-Slope Roof Systems Manual.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials with the Manufacturer's labels intact and legible.
- B. Deliver materials in sealed packages.
- C. Store materials on raised platforms and protect with coverings at outdoor locations.
- D. Store rolled goods on end.

1.6 SITE CONDITIONS
- A. Do not install underlayment or shingles at ambient or surface temperatures less than 40°F or on wet or frozen substrate.

1.7 WARRANTY
- A. Manufacturer:
  1. Warranty for 40 years from the Substantial Completion date for the satisfactory performance and installation of the asphalt shingle system and associated appurtenances, including coverage against water leakage through shingles.
  2. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the asphalt shingle system and associated appurtenances, including coverage against shingle discoloration due to algae growth.
  3. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the asphalt shingle system and associated appurtenances, including coverage shingle damage due to winds up to 130 mph.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Asphalt Shingles:
  1. CertainTeed Corporation, Northgate IR
  2. GAF Materials Corporation, Timberline ArmorShield II
  3. Malarkey Roofing, Legacy
  4. Owens Corning, Tru Definition Duration Flex
- B. Ice Dam Protection:
  1. W.R. Grace, Ice & Water Shield

2.2 MATERIALS

A. Asphalt Shingles:
   1. Fiber glass mat base, SBS modified, self-sealing, algae-resistant, in accordance with ASTM D 3462 and ASTM D 3018, Type I.
   2. In accordance with UL 2218 Class 4 impact resistance.
   3. Size: 13 1/4 inches by 39 3/8 inches.
   4. Exposure: 5 5/8 inches.
   5. Color: To be selected from the Manufacturer's full color range.
   6. Provide matching ridge shingles.

B. Roll Roofing: Asphalt-saturated roofing felt surfaced on one side with mineral granules, the same color as the shingles, in accordance with ASTM D 3909, Class M, Type II.

C. Maintenance:
   1. Extra materials: 100 sf of extra shingles.

2.3 ACCESSORIES

A. Underlayment: Non-perforated, in accordance with ASTM D 226, Type II, No. 30.

B. Ice Dam Protection:
   1. Minimum 40 mils thick polymer modified asphalt laminated to slip-resistant PE film, self-adhering with release paper facing, in accordance with ASTM D 1970.
   2. Elongation: Minimum 250%, tested in accordance with ASTM D 412.
   3. Tensile strength: Minimum 250 psi, tested in accordance with ASTM D 412.

C. Fasteners: Hot-dip galvanized steel nails, with a minimum 3/8 inch head diameter, 10 gauge barbed shank, with a length to penetrate a minimum of 3/4 inch into the sheathing.

D. Plastic Cement: Non-running, heavy body material composed of asphalt and other mineral ingredients, in accordance with ASTM D 4586, Type I.

E. Metal Flashings: As specified in SECTION 07 62 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Ice Dam Protection:
   1. Starting from the eave edge of the roof, apply underlayment horizontally on the roof. Weather lap each sheet 4 inches over the preceding sheet. Lap ends 6 inches at a minimum.
   2. Press to full bond with substrate without voids, wrinkles, bridging, or fishmouths. Seal ends and edges.
   3. Extend ice dam protection a minimum of 24 inches beyond the interior face of exterior walls.

B. Underlayment:
   1. Starting at the low edge, apply one ply of underlayment horizontally over the substrate.
   2. Weather lap each strip 4 inches over the previous strip at a minimum.
   3. Lap ends 6 inches at a minimum.
   4. Fasten the top of each strip under the overlapping strip to hold the strip in position until the shingles are installed.
   5. Provide an 18-inch weave pattern at valleys.
   6. Lap underlayment a minimum of 12 inches over the hips and the ridges from both sides. Apply a 36 inch wide strip centered lengthwise over the ridge. Nail at 12 inches on center on each side.
   7. Extend a minimum of 4 inches up abutting vertical surfaces.

C. Shingles:
   1. Install shingles in accordance with the Manufacturer's instructions.
   2. Provide a double course of shingles at eaves. Extend shingles 3/8 inch beyond the metal drip edges.
   3. Place shingles in a straight coursing pattern, in straight horizontal lines square with building lines, with the recommended exposure.
   4. Remove foreign matter between shingles to ensure uniform contact.
   5. Cut shingles at the perimeter and around penetrations. Do not use damaged shingles.
   6. Fasten shingles in the Manufacturer’s recommended weather exposure pattern. Use the number of fasteners per shingle that are recommended by the Manufacturer and that comply with wind warranty requirements.
   7. Closed valleys: Extend shingles on both slopes across the valley in a weave pattern and fasten. Extend shingles a minimum of 12 inches beyond the valley centerline to achieve a woven valley, concealing the valley protection.
   8. Open valleys: Fasten shingles along the nailing guideline through the laminated portion with a minimum of four fasteners per shingle.
   9. Cap hips and ridges with individual shingles maintaining the same exposure as the shingles.

D. Flashings:
   1. Rake edges:
      a. Install a metal drip edge at rake edges with the top flange on the top of underlayment.
      b. Weather lap ends a minimum of 2 inches and seal with plastic cement.
      c. Nail the top flange to the decking at a maximum of 8 inches on center.
      d. Apply plastic cement to cover the nail heads and at the edge of flashings for the entire length of metal.
   2. Drip edges:
      a. Apply a drip edge at the eave with the top flange directly on the deck; extend underlayment to the outer face of the drip edge.
      b. Lap ends a minimum of 2 inches and seal with plastic cement.
      c. Nail in place at a maximum of 8 inches on center.
      d. Apply plastic cement to cover the nail heads and at the edge of the flashings for the entire length of the metal.

3. Open valleys, as shown on the Drawings:
   a. Apply one layer of 36 inch wide underlayment and ice dam protection centered over valleys. Weather lap joints 12 inches at a minimum.
   b. Nail at 18 inches on center, with nails located within 1 inch of the edges.
4. Closed valleys, as shown on the Drawings:
   a. Apply one layer of 36 inch wide underlayment and ice dam protection centered over valleys. Weather lap joints 12 inches at a minimum.
   b. Nail at 18 inches on center, with nails located within 1 inch of the edges.
5. Stepped flashings:
   a. Install 4 inch high by 2 inch wide by 7 inch long pieces concurrent with the shingles. Place with ends slightly above with shingle butt ends.
   b. Place stepped counterflashing over tins at masonry.
6. Round penetrations:
   a. Place a preformed flashing boot over the penetration.
   b. Fasten the flange to the deck with a minimum of four fasteners.
   c. Tighten the draw band to a watertight condition.
7. Other flashings:
   a. Weather lap ends a minimum of 2 inches and seal with plastic cement.
   b. Nail in place at a maximum of 8 inches on center.
   c. Apply plastic cement to cover nail heads and at the edge of flashings for the entire length of metal.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 41 13
STANDING SEAM METAL ROOF PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for standing seam metal roof panels.

B. Related Sections:

1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
3. SECTION 01 40 00 – QUALITY REQUIREMENTS
4. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
5. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
6. SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

1.2 REFERENCES

A. ASTM International (ASTM):

1. A 755 – Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
2. A 792 – Standard Specification for. Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot- Dip Process
3. C 1177 – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
4. C 1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
5. C 1311 – Standard Specification for Solvent Release Sealants
6. D 1970 – Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
7. D 2244 – Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
8. D 4214 – Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
9. E 1592 – Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
10. E 1646 – Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
11. E 1680 – Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems

B. FM Global (FMG):

1. 4470 – Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction

C. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products.

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. 1793 – Architectural Sheet Metal Manual.

E. The Society for Protective Coatings (SSPC):

1. Paint 12 – Cold-Applied Asphalt Mastic (Extra Thick Film)

F. Underwriters Laboratories, Inc. (UL):

1. 580 – Tests for Uplift Resistance of Roof Assemblies

1.3 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.4 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal roof panels with rain drainage Work, flashing, trim, and construction of decks, parapets, walls, and other adjoining Work to provide a leak-proof, secure, and noncorrosive installation.

1.5 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meeting: Conduct meeting at the Project site.

1. Meet with the ENGINEER, CONTRACTOR, and OWNER's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, Metal Roof Panel Manufacturer's representative, Deck Installer, and installers whose Work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.
2. Review and finalize the construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal roof panel installation, including the Manufacturer's instructions.
4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
8. Review temporary protection requirements for metal roof panel assembly during and after installation.
9. Review roof observation and repair procedures after metal roof panel installation.

10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 SUBMITTALS

A. Submit Drawings as specified in SECTION 01 33 00.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.

C. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and end lap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled Work.
   1. Accessories: Include details of flashing and trim in conjunction with the requirement as specified in SECTION 07 62 00.

D. Samples for Color Selection: Color selector showing the full range of Manufacturer's standard colors.

E. Samples for Verification: Two samples of each color requested by the ENGINEER for selection.
   1. Metal roof panels: The Manufacturer's standard size samples.

F. Delegated-Design Submittal: The metal roof panel assembly indicated shall be in accordance with performance requirements and design criteria, including analysis data prepared, signed, and sealed by the Professional Engineer registered in the State of Colorado.

G. Manufacturer Certificates: Signed by the Manufacturer certifying that the roof panels are in accordance with the performance requirements as specified in this Section.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

I. Warranties: Samples of special warranties.

J. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).

1.7 QUALITY ASSURANCE

A. As specified in SECTION 01 40 00.
   1. Installer qualifications: An employer of workers trained and approved by the Manufacturer.
   2. Source limitations: Obtain each type of metal roof panels from a single source from a single Manufacturer.

B. Design Criteria:
   1. General performance: Metal roof panels shall be in accordance with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   2. Delegated design: Design the metal roof panel assembly, including comprehensive engineering analysis by a Professional Engineer registered in the State of Colorado, using performance requirements and design criteria indicated.
   3. Air infiltration: Air leakage through assembly of not more than 0.022 cfm/lf of joint when tested in accordance with ASTM E 1680 at the following test-pressure difference:
      a. Positive preload test-pressure difference: Greater than or equal to 12.0 lbf/sf.
   4. Water penetration: No water penetration through panel joints when tested in accordance with ASTM E 1646 at the following test-pressure difference:
      a. Positive preload test-pressure difference: Greater than or equal to 15.0 lbf/sf.
   5. Wind-uplift resistance: Provide metal roof panel assemblies that are in accordance with UL 580 for wind-uplift-resistance class indicated.
   6. Structural performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions shown on the Drawings, based on testing in accordance with ASTM E 1592.
      a. Wind loads: As shown on the Drawings.
      b. Deflection limits: Metal roof panel assemblies shall withstand wind and snow loads with vertical deflections no greater than 1/180 of the span.
   7. Thermal movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
      a. Temperature change (range): 120°F, ambient; 180°F, material surfaces.

1.8 DELIVERY, STORAGE, AND HANDLING

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
   1. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
   2. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
   3. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
   4. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.
   5. Protect foam-plastic insulation as follows:
      a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
      b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to the Project site before installation time.
      c. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.9 SITE CONDITIONS
A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel Work to be performed in accordance with the Manufacturer's instructions and warranty requirements.
B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.10 WARRANTY
A. As specified in SECTION 01 60 00.
B. Installer's Warranty: The Installer's standard form in which Installer agrees to repair or replace the metal roof panel assemblies that fail in materials or workmanship within the specified warranty period.
1. Failures include, but are not limited to, the following:
a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Failure to remain weathertight, including leaks.
2. Warranty period: 2 years from date of Substantial Completion.
C. Special Warranty on Panel Finishes: The Manufacturer's standard form in which the Manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within the specified warranty period.
1. Exposed panel finish: Deterioration includes, but is not limited to, the following:
a. Color fading more than five Hunter units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish warranty period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Standing Seam Metal Roof Panels:
1. AEP-Span, Span-Lok hp
2. ATAS International, Inc., Field-Lok FLR 154
3. CENTRIA Architectural Systems, SDP 200
B. Seam-Mounted, Bar-Type Snow Guards:
1. Action Manufacturing, SNOBAR
2. Alpine Snowguards
3. S-5 Snow Retention Systems, S-5 Colorgard
C. Underlayment:
1. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc., CCW WIP 300HT
2. Henry Company, Blueskin PE200 HT
3. Protecto Wrap Company, Jiffy Seal Ice & Water Guard HT
D. Substrate Boards:
1. Georgia-Pacific Corporation, DensDeck

2.2 MATERIALS
A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process in accordance with ASTM A 755.
1. Aluminum-zinc alloy-coated steel sheet: In accordance with ASTM A 792, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
2. Surface: Smooth, flat finish.
B. Standing-Seam Metal Roof Panels:
1. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
2. Vertical-rib, seamed-joint, standing-seam metal roof panels. Formed with vertical ribs at the panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching the panels to supports using concealed clips located under one side of the panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
a. Material: Aluminum-zinc alloy-coated steel sheet, 22 gauge 0.034 inch nominal thickness.
1) Exterior finish: Two-coat fluoropolymer.
2) Color: As selected by the ENGINEER from the Manufacturer's full range in accordance with the procedures specified in SECTION 01 33 00.
b. Clips: Floating to accommodate thermal movement.
1) Material: 0.064 inch nominal thickness, zinc-coated (galvanized) steel sheet.
c. Joint type: Single folded.
d. Panel coverage: 16 inches nominal, no stiffening ribs.
e. Panel height: 2 inches.
C. Roof Panel Trim: Provide components approved by the Roof Panel Manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise shown on the Drawings.
1. Closures: Provide closures at eaves and ridges, fabricated of the same metal as the metal roof panels.

2. Closure strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated PE; minimum 1 inch thick, flexible closure strips; cut or pre-molded to match metal roof panel profile. Provide closure strips where shown on the Drawings or necessary to ensure weathertight construction.
3. Backing plates: Provide metal backing plates at panel end splices, fabricated from material recommended by the Manufacturer.

D. Flashing and Trim: Formed from the same material as the roof panels, prefinished with coil coating, minimum 0.033 inch thick unless otherwise shown on the Drawings. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels. Comply with the requirements specified in SECTION 07 62 00.

2.3 ACCESSORIES

A. Panel Sealants: Butyl-rubber-based, solvent-release sealant in accordance with ASTM C 1311.

B. Field-Installed Thermal Insulation:
1. Faced, polyisocyanurate board insulation: In accordance with ASTM C 1289, Type II, Class 1 or 2 felt or glass-fiber mat, Grade 3 with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core.

C. Underlayment Materials:
1. Self-adhering, high-temperature sheet: 30 mils to 40 mils thick minimum, consisting of slip-resisting, PE-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by the Underlayment Manufacturer.
a. Thermal stability: Stable after testing at 240°F, in accordance with ASTM D 1970.
b. Low-temperature flexibility: Passes after testing at -20°F; In accordance with ASTM D 1970.
2. Primer: Type as recommended by the Underlayment Manufacturer for adherence to specified substrate boards.

D. Substrate Boards:
1. Glass-mat gypsum sheathing board:
a. In accordance with ASTM C 1177.
b. Type and thickness: Regular, 1/2 inch.
2. Substrate-board fasteners: Factory-coated steel fasteners and metal or plastic plates in accordance with the corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to substrate.

E. Panel fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching the color of the metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

F. Bituminous coating: Cold-applied asphalt mastic, SSPC Paint 12, compounded for 15 mil DFT per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

G. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.
1. Seam-mounted, bar-type snow guards: Aluminum rods or bars held in place by SST clamps attached to vertical ribs of standing-seam metal roof panels.
2. Aluminm finish: Components shall be painted to match the roof panel color.

2.4 FABRICATION

A. Fabricate and finish metal roof panels and accessories at the factory to the greatest extent possible, by the Manufacturer's standard procedures and processes and as necessary to fulfill performance requirements as specified in this Section. Fabrication shall be in accordance with profiles and dimensional and structural requirements as shown on the Drawings.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.

D. Sheet Metal Accessories: Fabricate flashing and trim as specified in SECTION 07 62 00.

2.5 FINISHES

A. Exposed Coil-coated Finish:
1. Two-coat fluoropolymer. Fluoropolymer finish containing not less than 70% PVDF resin by weight in colorcoat. Prepare, pretreat, and apply coating to exposed metal surfaces in accordance with the Coating and Resin Manufacturer’s instructions.
2. Concealed finish: Apply pretreatment and the Manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total DFT of 0.5 mil.

B. Application and designation of finishes shall be in accordance with NAAMM Metal Finishes Manual for Architectural and Metal Products.

C. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Appearance of Finished Work: Noticeable variations in the same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of accepted samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 GENERAL

A. Examine substrates, areas, and conditions, with the Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.

B. Examine roof framing and deck to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by the Metal Roof Panel Manufacturer.
C. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
D. For the record, prepare a written report, endorsed by the Installer, listing conditions detrimental to performance of the Work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
B. Install substrate boards over roof insulation on the entire roof surface. Attach with substrate-board fasteners to metal deck in accordance with wind uplift requirements.
C. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

3.3 INSTALLATION

A. Underlayment Installation:
   1. Self-adhering sheet underlayment: Apply primer if required by the Manufacturer. Installation shall be in accordance with the temperature restrictions of the Underlayment Manufacturer. Apply at the locations shown on the Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3 1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
      a. Apply over the entire roof surface.
   2. Install flashings to cover underlayment as specified in SECTION 07 62 00.
B. Thermal Insulation Installation:
   1. Board insulation: Extend insulation in thickness shown on the Drawings to cover entire roof.
C. Metal Roof Panel Installation, General:
   1. Provide metal roof panels of full length from eave to ridge unless otherwise shown on the Drawings or restricted by shipping limitations.
   2. Install metal roof panels as follows:
      a. Field cutting of metal panels by torch is not permitted.
      b. Locate and space fastenings in uniform vertical and horizontal alignment.
      c. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
      d. Install ridge caps as metal roof panel Work proceeds.
      e. Install metal flashing to allow moisture to run over and off metal roof panels.
   3. Fasteners:
      a. Steel roof panels and trim: SST steel rivets, type best suited to application; provided by the Manufacturer with head color to match panels where exposed. Paint touch-up of exposed rivets will be cause for rejection.
   4. Anchor clips: Anchor metal roof panels and other components of the Work securely in place, using the Manufacturer's approved fasteners in accordance with the Manufacturer's instructions.
   5. Metal protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by the Metal Roof Panel Manufacturer.
      a. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
   6. Joint sealers: Install gaskets, joint fillers, and sealants where shown on the Drawings and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by the Metal Roof Panel Manufacturer.
D. Metal Roof Panel Installation:
   1. Standing-seam metal roof panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by the Manufacturer, and in compliance with specified spacing to meet wind uplift requirements.
      a. Install clips to supports with self-tapping fasteners.
      b. Install pressure plates at locations in accordance with the Manufacturer's installation instructions.
      c. Seamed joint: Crimp standing seams with Manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
   2. Concealed clip spacing: Install concealed clips at locations shown on the Drawings with spacing to meet wind uplift requirements as follows:
      a. Field: 48 inches on center.
      b. Edge zone: 24 inches on center.
      c. Corner zone: 18 inches on center.
E. Accessory Installation:
   1. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
      a. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items, as specified in SECTION 07 62 00.

2. Flashing and trim: In accordance with the performance requirements, the Manufacturer's installation instructions, SMACNA 1793, and as specified in SECTION 07 62 00.
3. Pipe flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by the Manufacturer.

F. Snow Guard Installation:
1. Bar-type snow guards: Attach bar supports to vertical ribs of standing-seam metal roof panels with clamps or set screws. Do not use fasteners that will penetrate metal roof panels.
   a. Provide rows of snow guards, at locations shown on the Drawings.

G. Erection Tolerances:
1. Installation tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as shown on the Drawings and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

3.4 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in the Manufacturer's installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by the Metal Roof Panel Manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 51 13
BUILT-UP ASPHALT ROOFING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for built-up asphalt roofing.
- B. Related Sections:
  1. SECTION 06 10 00 – ROUGH CARPENTRY
  2. SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

1.2 REFERENCES
- A. American Society of Civil Engineers (ASCE):
  1. 7 – Minimum Design Loads for Buildings and Other Structures
- B. ASTM International (ASTM):
  1. C 728 – Standard Specification for Perlite Thermal Insulation Board
  2. C 1177 – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  3. C 1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
  4. D 41 – Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
  5. D 312 – Standard Specification for Asphalt Used in Roofing
  6. D 1863 – Standard Specification for Mineral Aggregate Used on Built-Up Roofs
  7. D 2178 – Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
  8. D 4586 – Standard Specification for Asphalt-Roof Cement, Asbestos-Free
  9. D 4601 – Standard Specification for Asphalt Coated Glass Fiber Base Sheet Used in Roofing
  10. D 6221 – Standard Specification for Reinforced Bituminous Flashing Sheets for Roofing and Waterproofing
  11. E 108 – Standard Test Methods for Fire Tests of Roof Coverings
  12. E 119 – Standard Test Method for Fire Tests of Building Construction and Materials
- C. National Roofing Contractors Association (NRCA):
  1. Roofing and Waterproofing Manual
- D. Underwriters Laboratories (UL):
  1. 790 – Standard Test Methods for Fire Tests of Roof Coverings

1.3 SEQUENCING AND SCHEDULING
- A. Do not install more insulation than can be protected with roofing during the same day.
- B. Staging of the roof membrane application or the temporary membrane is not acceptable; install the system in final form each day. If phased roofing occurs as a result of emergency conditions, install additional plies over phased areas.
- C. Install temporary waterproof transitions at the exposed edges of the roofing system if Work is stopped due to adverse weather conditions.
- D. Complete flashings daily.

1.4 PRE-INSTALLATION MEETING
- A. Convene at the site 2 weeks prior to beginning the Work of this Section.
- B. Attendance: ENGINEER, CONTRACTOR, Roofing Installer, Roofing Manufacturer's Representative, Deck Installer, and related trades.
- C. Review and Discuss: Contract Documents, Roofing System Manufacturer's literature, site conditions, scheduling, and other matters affecting application.
- D. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
- E. Review structural loading limitations of the roof deck during and after roofing.
- F. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and the condition of other construction that will affect the roofing system.
- G. Review temporary protection requirements for the roofing system during and after installation.

1.5 SUBMITTALS
- A. Product Data: Manufacturer's product specifications, installation instructions, and general recommendations for each principal roofing product; include bitumen softening point, flash point, EVT, and finished blowing temperature.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work; indicate:
  1. Base flashings, cants, and membrane terminations.
  2. Tapered insulation, including roof slopes.
  3. Base flashing, termination, and special details.
  4. Crickets, saddles, and tapered edge strips, including slopes.
  5. Insulation fastening patterns.
- C. Samples:
  1. 1 gallon container of gravel surfacing showing color and gradation.
  2. The Manufacturer’s standard size flashing sheet samples in the specified color.
  3. The Manufacturer’s standard size cover board sample.
  4. The Manufacturer’s standard size roof insulation sample.
  5. The Manufacturer’s standard size walkway pad sample.
- D. Quality Control Submittals:
  1. Provide certification from an independent testing laboratory that the roofing system meets fire hazard and windstorm classification requirements.
  2. Installer certificates: Signed by the Roofing System Manufacturer certifying the installer is approved, authorized, or licensed by the Manufacturer to install the roofing system.

3. Manufacturer certificates: Signed by the Roofing Manufacturer certifying the roofing system complies with the requirements specified.
4. SDS for specified products.
5. Roofing Installer: 2 year warranty on the standard NRCA form.

E. Warranty Documentation:
1. Sample warranty.
2. Installation warranty.
3. Warranty.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications:
1. A minimum of 5 years of documented experience in the Work of this Section.
2. Licensed or certified by the Roofing Materials Manufacturer.

B. Manufacturer Qualifications:
1. A minimum of 5 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.
3. UL Class A Fire Rating certification for the roofing system identical to that used for this Work.

C. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics as shown on the Drawings or as determined by testing identical products in accordance with the test method below by UL or another testing and inspecting agency acceptable to the AHJs. Materials shall be identified with appropriate markings of the applicable testing and inspecting agency.
1. Exterior fire-test exposure: UL Class A Fire Hazard Classification, tested in accordance with ASTM E 108 and UL 790.
2. Fire resistance ratings: Fire-resistance-rated roof assemblies of which the roofing system is a part, in accordance with ASTM E 119.

D. Performance Requirements:
1. General: Provide installed four ply roofing membrane and base flashings that remain watertight, that do not permit the passage of water, and that resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
2. Material compatibility: Provide roofing materials compatible with one another under the conditions of service and the application required as demonstrated by the Roofing Manufacturer based on testing and field experience that are warrantable under one warranty.
3. Provide a roofing system identical to the systems successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated in accordance with ASCE 7.
4. For roof installations on decks above open water storage basins, provide a vapor retarder installed on a substrate board in the roofing system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Provide products in the Manufacturer's original, dry, undamaged containers with seals and labels intact.
B. Handle rolled goods to prevent damage to ends.
C. Protect materials against moisture absorption, direct sunlight, damage, and temperatures above 110°F and below 40°F.
D. Store materials off the ground or the roof deck on pallets. Cover materials stored outside with properly vented breathable covering.
E. Stockpile gravel surfacing near the building in a clean, well-drained area. Prevent the inclusion of vegetation, building debris, and other deleterious material in the surfacing.

1.8 SITE CONDITIONS

A. Environmental Requirements:
1. Do not apply roofing to damp, wet, or frozen substrates, or during precipitation.
2. Do not apply emulsions when the temperature is below 40°F, or if freezing weather is anticipated within 1 day after application.
3. Do not use frozen materials.
4. Proceed with installation only when existing and forecasted weather conditions permit the roofing system to be installed in accordance with the Manufacturer's instructions and warranty requirements.

1.9 WARRANTY

A. Manufacturer: Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the built-up asphalt roofing system and associated appurtenances, including a no dollar limit system warranty providing coverage against water leakage through the roofing system.
B. Installer: Warranty for 2 years from the Substantial Completion date, or provide a standard NRCA form, for the satisfactory performance and installation of the built-up asphalt roofing system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Rigid Insulation:
1. Johns Manville, ENRGY 3

B. Flashing Backer Sheet:
1. Johns Manville, PermaPly 28

C. Vapor Retarder (where required):
1. Johns Manville, GlasPly IV

D. Roofing Felts:
   1. Johns Manville, GlasPly Premier
E. Flashing Sheet:
   1. Johns Manville, DynaFlex
F. Asphalt Roof Cement:
   1. Johns Manville, Bestile Utility Cement
G. Cold-Applied Flashing Adhesive:
   1. Johns Manville, MBR Flashing Cement
H. Edge Strips:
   1. Johns Manville, Tapered Fesco Edge Strip
I. Cant Strips:
   1. Johns Manville, FesCant Plus
J. Walkway Pads:
   1. Johns Manville, DynaTred
K. Cover Board:
   1. Johns Manville, 1/2 inch RetroPlus
L. Fasteners:
   1. Johns Manville, UltraFast Fasteners and Plates
M. Expansion Joint Covers:
   1. Johns Manville, Expand-O-Flash
N. Substrate Board (where required):
   1. Johns Manville, DensDeck Prime

2.2 MATERIALS

A. Rigid Insulation:
   1. Type: Rigid polyisocyanurate faced both sides with glass fiber mat facings, in accordance with ASTM C 1289, Type II, Class 1, Grade 2.
   2. Thickness: As shown on the Drawings.
   3. Thermal resistance: R-value of 5.7 per inch.
   4. If insulation is to be tapered, provide board tapered to 1/4 in/ft.
B. Flashing Backer Sheet: Asphalt impregnated, glass fiber felt, in accordance with ASTM D 4601, Type II.
C. Vapor Retarder (where required by 1.6.D.4): Asphalt impregnated, glass fiber felt, in accordance with ASTM D 2178, Type IV.
D. Roofing Felts: Asphalt impregnated glass fiber felt, in accordance with ASTM D 2178, Type VI.
E. Flashing Sheet: Polyester and glass fiber reinforced, SBS-modified asphalt sheet; granular surfaced, in accordance with ASTM D 6221, Grade G, Type I.
F. Roofing Asphalt: In accordance with ASTM D 312, the type applicable to the slope.
G. Primer: In accordance with ASTM D 41.
H. Asphalt Roof Cement: Asbestos free, in accordance with ASTM D 4586.
I. Gravel Surfacing: Washed gravel, size No. 6, tan, in accordance with ASTM D 1863.
J. Cold-Applied Flashing Adhesive: Asphalt-based, two-component, asbestos free.

2.3 ACCESSORIES

A. Edge Strips: Perlite, fabricated to the slopes shown on the Drawings in accordance with ASTM C 728.
B. Cant Strips: Perlite, 4 inch nominal vertical height, 45 degree face in accordance with ASTM C 728.
C. Walkway Pads: The Roofing System Manufacturer's reinforced modified asphalt composition, mineral-surfaced, slip-resistant pads, 32 inch by 32 inch.
D. Cover Board: Perlite, in accordance with ASTM C 728, Type 3.
E. Fasteners: Factory-coated corrosion-resistant steel fasteners and metal plates or plastic plates; provided by and tested by the Roofing System Manufacturer for required pullout strength; type and length suited to the site conditions.
F. Expansion Joint Covers:
   1. Type: EPDM cover over closed-cell foam insulation, bonded to galvanized steel flanges, with preformed corners and intersections.
   2. Provide the product included in specified warranty.
G. Nailers and Curbs: As specified in SECTION 06 10 00.
H. Metal Flashings: As specified in SECTION 07 62 00.
I. Substrate Board (where required in this Section): ASTM C 1177, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates and conditions for compliance with the requirements for installation tolerances and other conditions affecting the performance of the roofing system.
B. Verify that deck surfaces are dry and free of dirt and debris.
C. Verify that roof openings and penetrations are in place, set, and braced.
D. Verify that wood cants, blocking, curbs, and nailers are securely anchored to the roof deck and that nailers match the thicknesses of insulation.
E. Proceed with installation only after unsatisfactory conditions are corrected.
F. Clean substrate of dust, debris, moisture, and other substances detrimental to the roofing installation.

G. Prevent materials from entering and clogging roof drains and ensure free flowing roof drains throughout roof Work.
H. Protect adjacent and underlying surfaces.

3.2 INSTALLATION

A. General: Apply the roofing system in accordance with the Manufacturer's instructions, the NRCA Roofing and Waterproofing Manual, and the approved Shop Drawings.
B. Insulation and Cover Board:
   1. Coordinate the installation of roof system components so that insulation and cover board are not exposed to precipitation or left exposed at the end of the workday.
   2. Insulation cant strips: Install and secure preformed 45 degree insulation cant strips at the junctures of the roofing membrane system with vertical surfaces or angle changes greater than 45 degrees in accordance with the Manufacturer's instruction.
   3. Apply a base layer with long edges continuous and perpendicular to deck ribs. Stagger end joints in adjacent rows. Locate ends over solid bearing. First layer of insulation shall be mechanically attached to deck.
   4. Install additional layers of insulation and cover board under the area of roofing to achieve the required R-value in hot asphalt. Install layers with the joints of each successive layer staggered from the joints of the previous layer a minimum of 6 inches in each direction.
   5. Mechanically fasten to the substrate in the Manufacturer's recommended fastening pattern for the corner, perimeter, and field uplift pressures specified.
   6. Trim the surface of the boards where necessary at roof drains so the completed surface is flush and does not restrict the flow of water.
   7. Install tapered edge strips at perimeter edges of the roof that do not terminate at vertical surfaces.
   8. On roof installations requiring a vapor retarder: Mechanically fasten the substrate board to the deck in the Manufacturer's recommended fastening pattern for the corner, perimeter, and field uplift pressures specified. Mop in the vapor retarder, layers of insulation, and cover board.
C. Roofing:
   1. Roofing felts:
      a. Starting at the low edge, apply four plies of roofing felt.
      b. Align ply sheets without stretching.
      c. Shingle side laps of ply sheets uniformly to achieve the required number of plies throughout the roofing membrane. Shingle in the direction to shed water.
      d. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at the rate required by the Roofing System Manufacturer.
      e. Broom plies to full contact with bitumen without voids and wrinkles.
      f. Extend ply sheets over, and terminate beyond, cants.
   2. Install waterstops at the exposed edges of insulation if Work is stopped due to adverse weather conditions.
      a. Cement half of the 12 inch wide strip of felt to the deck, double back over the exposed edge and mop solidly on top of the insulation.
      b. Do not cut off staggered boards at the edge of insulation; temporarily fill with loose pieces of insulation.
      c. Remove waterstops and loose insulation when Work is resumed.
D. Flashings:
   1. Metal flashings:
      a. Prime metal flanges.
      b. Nail flanges at 3 inches on center at a maximum.
      c. Strip in with one ply of roofing membrane.
   2. Membrane base flashings: Install over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through the roof; secure to substrates according to the Roofing System Manufacturer's instructions and as follows:
      a. Prime concrete and masonry surfaces.
      b. Backer sheet to wood-surfaced walls: Mechanically fasten backer sheet to substrate. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt.
      c. Backer sheet to masonry or concrete substrate: Install backer sheet and adhere to substrate in a solid mopping of hot roofing asphalt.
      d. Flashing sheet: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at EVT. Apply hot roofing asphalt to the back of the flashing sheet if recommended by the Roofing System Manufacturer.
      e. Extend base flashing up walls or parapets a minimum of 8 inches above the roofing membrane and 4 inches onto the field of the roofing membrane.
      f. Mechanically fasten the top of the base flashing securely at the terminations and at the perimeter of roofing at a rate given by the Roofing System Manufacturer.
      g. Seal the top termination of the base flashing with a strip of glass fiber fabric set in flashing cement.
      h. Mechanically fasten the top edge of flashing to substrate and seal with metal flashing.
   3. Roof drain flashing:
      a. Set 30 inch by 3 inch, 4 lb lead flashing sheet in a bed of flashing cement on roofing membrane.
      b. Cover metal flashing with roofing membrane cap-sheet stripping. Extend a minimum of 4 inches beyond the edge of metal flashing onto the roofing membrane.
      c. Clamp roofing membrane, metal flashing, and stripping into a roof-drain clamping ring.

E. Expansion Joints:
   1. Complete roof membrane and flashing installation prior to installing the expansion joint.
   2. Set the joint cover on top of wood nailers; secure on each side through a metal flange.
   3. Seal the joint cover flanges to the membrane.

F. Walkway Pads:
   1. Sweep away loose aggregate surfacing prior to placing; set in a solid mopping of hot bitumen.
   2. Leave a 3 inch to 6 inch space between pieces.

G. Roof Vents: Install one-way roof vents in accordance with the Manufacturer's recommendation.

H. Installations Requiring a Vapor Retarder:
   1. Install two glass fiber felt plies lapping each sheet 19 inches over the preceding sheet.
   2. Embed each sheet in a solid mopping of hot roofing asphalt applied at a rate of 23 lbs/sq, ±25%.
   3. Completely seal vapor retarder at terminations, obstructions, and penetrations.

I. Roofing Asphalt:
   1. Do not heat within 25ºF of flash point; apply before bitumen cools below the application temperature.
   2. Do not raise the roofing asphalt temperature above the EVT range more than 1 hour before the time of application.
   3. Apply at EVT, with a maximum temperature tolerance of ±25°F. Check the temperature regularly at the point of application.
   4. Do not heat above the finished blowing temperature for longer than 4 hours. If heated above the finished blowing temperature, allow the roofing to cool to the specified temperature before applying. Discard roofing asphalt maintained at a temperature exceeding the finished blowing temperature for more than 4 hours.
   5. Maximum deviation from the quantity specified: ±15%.
   6. Mop solidly under each felt and a minimum of 1/2 inch beyond edges so that felt does not touch felt.
   7. Do not apply when foaming, blistering, or bubbling of bitumen occurs.

J. Gravel Surfacing:
   1. Flood the surface with hot bitumen at a rate of 60 lbs/sq.
   2. Embed gravel surfacing at a rate of 400 lbs/sq.
   3. Remove loose gravel surfacing from rooftop.

3.3 PROTECTION

A. Protect the roofing system from damage and wear through the Final Completion date.

3.4 QUALITY CONTROL

A. Testing Agency: The OWNER may engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for the Roofing System Manufacturer's technical personnel to inspect the roofing installation on completion and submit a report to the Roofing Contractor to submit to the ENGINEER.

C. Repair or remove and replace components of the roofing system where test results or inspections indicate they do not comply with the specified requirements.

D. Perform additional testing and inspection at the CONTRACTOR's expense to determine the compliance of replaced or additional Work with the specified requirements.

3.5 CLEANING

A. Clean overspray and spillage from adjacent construction using the cleaning agents and procedures recommended by the Manufacturer of the affected construction.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 53 00
ELASTOMERIC MEMBRANE ROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for elastomeric membrane roofing.

B. Related Sections:

1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
3. SECTION 01 40 00 – QUALITY REQUIREMENTS
4. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
5. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
6. SECTION 05 31 00 – STEEL ROOF DECKING

1.2 REFERENCES

A. American National Standards Institute/FM Global (ANSI/FMG):

1. 4474 – American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.

B. American Society of Civil Engineers (ASCE):

1. 7 – Minimum Design Loads for Buildings and Other Structures

C. ASTM International (ASTM):

1. C 1177 – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
2. C 1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
3. D 1079 – Standard Terminology Relating to Roofing and Waterproofing
4. D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
5. D 4637 – Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
6. E 108 – Standard Test Methods for Fire Tests of Roof Coverings
7. E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

D. FM Global (FMG):

1. 4450 – Approval Standard for Class 1 Insulated Steel Deck Roofs
2. 4470 – Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction

E. International Code Council (ICC):

1. ES – Evaluation Service

F. National Roofing Contractors Association (NRCA):

1. Roofing Manual

1.3 DEFINITIONS

A. Roofing Terminology: Definitions of terms related to the roofing Work in this Section is in accordance with ASTM D 1079 and NRCA Roofing Manual.

1.4 SUBMITTALS

A. Warranty documentation as specified in SECTION 01 60 00.

B. O&M documentation as specified in SECTION 01 78 23.

C. Submit the following as specified in SECTION 01 33 00:

1. Product data: For each type of product indicated. Include data substantiating that materials comply with requirements.
2. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
   d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
3. Qualification data: For the qualified Installer and Manufacturer.
   a. Installer certificates: Signed by the Roofing System Manufacturer certifying the Installer is approved, authorized, or licensed by the Manufacturer to install the specified roofing system.
4. Manufacturer certificate: Signed by the Roofing Manufacturer certifying that membrane roofing system complies with requirements specified in this Section.
   a. Submit evidence of complying with performance requirements.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by the Manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
6. Research/evaluation reports: For components of membrane roofing system, from the ICC ES.
7. Maintenance data: Roofing system in accordance with the maintenance manuals as specified in SECTION 01 78 23.
8. Warranty: Sample copy of the standard Roofing System Manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.

D. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).

1.5 QUALITY ASSURANCE

A. As specified in SECTION 01 40 00.

B. Manufacturer Qualifications: A qualified Manufacturer for membrane roofing system identical to that used for this Project.

C. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by the Membrane Roofing System Manufacturer to install the Manufacturer's product and that is eligible to receive the Manufacturer's special warranty.
D. Installer's Experience: Continuously applied roofing materials in Colorado for a minimum of 5 years.
E. The Installer shall show evidence of experience in installing a minimum of three similar roofing systems on projects of similar size, scope and complexity.
F. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from the Manufacturer as approved by the Membrane Roofing Manufacturer.
G. Exterior Fire-Test Exposure: ASTM E 108 Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
H. Fire-Resistance Ratings: Where required by the Drawings, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance in accordance with ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
I. Roofing Conference: Conduct conference at the Project site:
    1. Meet with the ENGINEER, CONTRACTOR, and OWNER's insurer if applicable, testing and inspecting agency representative, Roofing Installer, Roofing System Manufacturer's Representative, Deck Installer, and Installers whose Work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
    2. Review methods and procedures related to roofing installation, including the Manufacturer's instructions.
    3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
    4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
    5. Review structural loading limitations of roof deck during and after roofing.
    6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect the roofing system.
    7. Review governing regulations and requirements for insurance and certificates if applicable.
    8. Review temporary protection requirements for roofing system during and after installation.
    9. Review roof observation and repair procedures after roofing installation.
J. Design Criteria:
    1. Performance requirements:
        a. General performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
        b. Material compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by the Membrane Roofing Manufacturer based on testing and field experience.
        c. Wind loads: As shown on the Drawings:
        d. Roofing system design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated in accordance with ASCE 7.
            1) Corner uplift pressure: As shown on the Drawings.
            2) Perimeter uplift pressure: As shown on the Drawings.
            3) Field-of-roof uplift pressure: As shown on the Drawings.
        e. FMG approvals listing: Provide membrane roofing, base flashings, and component materials that are in accordance with FMG 4450 and FMG 4470 as part of a membrane roofing system, and that are listed in FMG Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FMG Approvals' markings.
            1) Fire/windstorm classification: Class 1A-90. Roof system shall be in accordance with ANSI/FMG 4474.
            2) Hail resistance: SH.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
    1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with the Manufacturer's name, product brand name and type, date of manufacture, acceptance or listing agency markings, and directions for storing and mixing with other components.
    2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by the Roofing System Manufacturer. Protect stored liquid material from direct sunlight.
        a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
    3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with the Insulation Manufacturer's instructions for handling, storing, and protecting during installation.
    4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.7 SITE CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit the roofing system to be installed in accordance with the Manufacturer's instructions and warranty requirements.

1.8 WARRANTY

A. Special Warranty: The Manufacturer's standard or customized form, without monetary limitation, in which the Manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within the specified warranty period.
   1. Includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, and other components of the membrane roofing system.
   2. Warranty period: 20 years from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. EPDM Membrane Roofing:
   1. Carlisle SynTec Incorporated
   2. Firestone Building Products
   3. Genflex Roofing Systems
   4. Johns Manville

B. Insulation Accessories:
   1. Cover board:
      a. Georgia-Pacific Corporation, DensDeck Prime

C. Pipe Mounting Supports:
   1. RPS Curbs
   2. Cooper B-Line

2.2 MATERIALS

A. EPDM Membrane Roofing:
   1. In accordance with ASTM D 4637, Type I, non-reinforced, uniform, flexible EPDM sheet.
      a. Thickness: 60 mils, nominal.
      b. Exposed face color: White on black.
   2. Sheet flashing: 60 mil thick EPDM, partially cured or cured, in accordance with application.
   3. Bonding adhesive: The Manufacturer's standard.
   4. Seaming material: The Manufacturer's standard, synthetic-rubber polymer primer and 3 inch wide minimum, butyl splice tape with release film.
   5. Lap sealant: The Manufacturer's standard, single-component sealant, coloed to match membrane roofing.
   6. Water cutoff mastic: The Manufacturer's standard butyl mastic sealant.
   7. Metal termination bars: The Manufacturer's standard, predrilled SST or aluminum bars, approximately 1 inch by 1/8 inch thick; with anchors.
   8. Metal battens: The Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.
   9. Fasteners: Factory-coated steel fasteners and metal or plastic plates in accordance with the corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to the Roofing System Manufacturer.
   10. Miscellaneous accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

B. Roof Insulation:
   1. General: Preformed roof insulation boards manufactured or approved by the EPDM Membrane Roofing Manufacturer, selected from the Manufacturer's standard sizes suitable for application, of thicknesses as shown on the Drawings.
   2. Polyisocyanurate board insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
   3. Tapered insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1 to 48) unless otherwise shown on the Drawings.
   4. Cricket insulation: Provide factory-tapered insulation boards fabricated to slope of 1/2 inch per 12 inches (1 to 24) otherwise shown on the Drawings.
   5. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

C. Insulation Accessories:
   1. Furnish roof insulation accessories recommended by the Insulation Manufacturer for intended use and compatibility with membrane roofing.
   2. Fasteners: Factory-coated steel fasteners and metal or plastic plates in accordance with the corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to the Roofing System Manufacturer.
   3. Cover board: ASTM C 1177, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.

D. Walkways:
   1. Flexible walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick, and acceptable to the Membrane Roofing System Manufacturer.

E. Pipe Mounting Supports: Non-penetrating, UV stable, reinforced PVC or rubber supports installed 5 feet on center, designed to support 150 lb loads minimum, and including U-channel struts and necessary installation hardware to secure piping to supports.

PART 3 EXECUTION

3.1 GENERAL

A. Provide EPDM single-ply membrane roofing system as shown on the Drawings and in accordance with the Contract Documents:
   1. Adhered EPDM membrane roofing system.
   2. Walkway pads.
   3. Roof insulation.

3.2 PREPARATION

A. Examine substrates, areas, and conditions, with the Installer present, for compliance with the following requirements and other conditions affecting performance of the roofing system:
   1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that surface plane flatness and fastening of steel roof deck is as specified in SECTION 05 31 00.
   4. Verify that minimum concrete drying period recommended by the Roofing System Manufacturer has passed.
   5. Verify the concrete substrate is visibly dry and free of moisture. Test for capillary moisture by the plastic sheet method in accordance with ASTM D 4263.
   6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation in accordance with the Roofing System Manufacturer's instructions. Remove sharp projections.

D. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no Work is taking place or when rain is forecast.

E. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

3.3 INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Installation of roof insulation shall be in accordance with the Membrane Roofing System and Insulation Manufacturer's instructions.

C. Install tapered insulation under area of roofing to conform to slopes shown on the Drawings.

D. Install insulation under area of roofing to achieve required thickness. Install layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Mechanically fastened insulation installation:
   1. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
   2. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
   3. Install each layer of insulation in thickness required to achieve required R-value.
   4. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.
   5. Secure cover boards and insulation to deck with common mechanical fasteners specifically designed and sized for fastening specified cover board-type and roof insulation to deck type.
      a. Fasten cover boards and insulation in accordance with requirements in FMG Approvals' RoofNav for specified windstorm resistance classification.
      b. Fasten cover boards and insulation to resist uplift pressure at corners, perimeter, and field of roof.

G. Adhered Membrane Roofing Installation:
   1. Adhere fabric-backed membrane roofing over the area to receive roofing in accordance with the Membrane Roofing System Manufacturer's instructions. Unroll membrane roofing and allow to relax before installing.
   2. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by the Manufacturer. Stagger end laps.
   3. Bonding adhesive: Apply to substrate and underside of membrane roofing at the rate required by the Manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
   4. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
   5. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
   6. Adhesive seam installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing in accordance with the Manufacturer's instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
   7. Tape seam installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing in accordance with the Manufacturer's instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.

8. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
9. Spread sealant or mastic bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

H. Base Flashing Installation:
1. Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with the Membrane Roofing System Manufacturer's instructions.
2. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
4. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
5. Terminate and seal top of sheet flashings.

I. Walkway Installation:
1. Flexible walkways: Install walkway products in locations shown on the Drawings. Adhere walkway products to substrate with compatible adhesive in accordance with the Roofing System Manufacturer's instructions.

3.4 PROTECTION

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to the ENGINEER and the OWNER.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at the time of Substantial Completion and in accordance with warranty requirements.

3.5 QUALITY CONTROL

A. ORT Prerequisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER, shall be paid by the CONTRACTOR.
1. Testing agency: The OWNER will engage a qualified independent testing agency to perform inspections.
2. Final roof inspection: Arrange for the Roofing System Manufacturer's technical personnel to inspect roofing installation on completion.
3. Repair or remove and replace components of membrane roofing system where inspections indicate they do not comply with specified requirements.
4. Additional inspections, at the CONTRACTOR's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for sheet metal flashing and trim.
- B. Related Sections:
  1. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  2. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  3. A 755 – Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
  4. A 792 – Standard Specification for. Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot- Dip Process
  5. C 920 – Standard Specification for Elastomeric Joint Sealants
  6. C 1311 – Standard Specification for Solvent Release Sealants
  7. D 1187 – Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
  8. D 4586 – Standard Specification for Asphalt Roof Cement, Asbestos Free
  9. F 2329 – Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  1. 1793 – Architectural Sheet Metal Manual
- C. Underwriters Laboratories, Inc. (UL):
  1. 580 – Tests for Uplift Resistance of Roof Assemblies

1.3 SUBMITTALS
- A. Product Data: For each pre-manufactured item specified.
- B. Shop Drawings: Show locations, types, and thicknesses of metal, profiles, dimensions, fastening methods, provisions for expansion and contraction, and joint details.
- C. Samples:
  1. Each flashing and trim profile, minimum 12 inches long; include corners where applicable.
  2. Size: Prefinished metal samples, 3 inches by 3 inches, showing available colors.
- D. Quality Control Submittals: Certificates of compliance for sheet metal.
- E. Warranty Documentation:
  1. Sample warranty.
  2. Installation warranty.
  3. Warranty.

1.4 QUALITY ASSURANCE
- A. Fabricator and Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Pre-manufactured products approved by the Manufacturer.
- B. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  1. Wind-uplift resistance: Provide flashing and sheet metal assemblies in accordance with UL 580 for the wind-uplift-resistance class indicated.
     a. Uplift rating: 90 in accordance with UL 580.
  2. Structural performance: Provide metal roof panel assemblies capable of withstanding the wind criteria conditions as shown on the Drawings.
  3. Thermal movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
     a. Temperature change (range): 120°F, ambient; 120°F material surfaces.

1.5 WARRANTY
- A. Installer: Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the sheet metal flashing and trim system and associated appurtenances, including coverage against water leakage through flashing and sheet metal.
- B. Manufacturer: Warranty for 20 years from the Substantial Completion date for the satisfactory performance of the sheet metal flashing finish system, including coverage against chipping, cracking, fading, or delamination of panel finish. Provide for non-prorated material and replacement cost.
- C. Pre-Manufactured Coping: Manufacturer's standard 20-year warranty for coping system to perform without leaks or failure due to wind speeds up to 110 mph.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Pre-Manufactured Flashing System:
  1. Fry Reglet, Springlok Flashing System
- B. Pre-Manufactured Coping:
  1. OMG, Inc., Permasnap System

C. Fluorocarbon Coating:
   1. Arkema, 70% Kynar 500
D. Galvanized Steel Prefinished Coping System Coating:
   1. Arkema, 70% Kynar 500

2.2 MATERIALS

A. Galvanized Steel Sheet:
   1. Structural quality, 24 gauge core steel, in accordance with ASTM A 653, G90 coating class.
   2. Where sheet metal is to be painted, apply phosphate film at the factory.
B. Metallic Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and pre-painted by the coil coat process in accordance with ASTM A 755.
   1. Aluminum-zinc alloy coated steel sheet: In accordance with ASTM A 792, commercial quality, AZ50 aluminum-zinc alloy coating.
   2. Finish: Pre-coated with fluoropolymer coating, containing minimum 70% PVDF resins, to be selected from the Manufacturer's full color range.

2.3 COMPONENTS

A. Pre-Manufactured Flashing System:
   1. Reglets: Units of the type, material, and profile shown on the Drawings, formed to provide secure interlocking of separate reglet and counterflashing pieces, with factory-mitered and factory-welded corners and junctions.
      a. Description: Two-piece assembly with a reglet fabricated with a canted top designed to receive sealant, and a lower portion formed to provide secure interlocking to a separate counterflashing piece. The counterflashing shall fit into the reglet as required to rest securely against the wall substrate.
      b. Type: SM surface-mounted installation with pre-punched fastener holes in the upper reglet.
      c. Gauge, material, and finish: 24 gauge galvanized steel with standard zinc finish.
      d. Performance: Reglet and flashing system shall be certified by the Manufacturer to resist 110 mph wind loads for a minimum of 2 continuous hours.
      e. Accessories: Provide prefabricated reglet corners and drive pins with atmoseal SST washers with neoprene facing.
      f. Laps: Reglet shall have a 1 inch factory formed end lap; flashing shall have a 3 inch end lap.
B. Pre-Manufactured Coping:
   1. Galvanized steel prefinished coping system, with Kynar coating: 24 gauge.
   2. Concealed splice shall match the color and finish of cap.
   3. Galvanized steel anchor cleats: 20 gauge by 12 inch length.
   4. Provide the Manufacturer’s standard corners, end caps, and end terminations.
   5. Provide the Manufacturer’s standard 24 gauge steel spring coping supports.

2.4 ACCESSORIES

A. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by the Manufacturer of the primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
   2. Exposed fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
   3. Blind fasteners: High-strength SST rivets suitable for metal being fastened.
   4. Fasteners for aluminum zinc alloy coated steel sheet: Hot-dip galvanized steel in accordance with ASTM A 153, ASTM F 2329, or Series 300 SST.
   5. Fasteners for zinc coated galvanized sheet: Hot-dip galvanized steel in accordance with ASTM A 153 or ASTM F 2329 or Series 300 SST.
B. Sealant Tape: Pressure sensitive, 100% solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, non-toxic, no-staining tape 1/2 inch wide and 1/8 inch thick.
C. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
D. Butyl Sealant: ASTM C 1311, single component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
E. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D 1187.
F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION

A. General:
   1. Custom fabricate sheet metal flashing and trim in accordance with SMACNA 1793 that apply to design, dimensions, geometry, metal thickness, and other characteristics of item as shown on the Drawings. Fabricate items at the shop to greatest extent possible.
      a. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
      b. Obtain field measurements for accurate fit before shop fabrication.
      c. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels as shown on the Drawings, with exposed edges folded back to form hems.
      d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

2. Fabrication tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as shown on the Drawings and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.
3. Sealed joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to be in accordance with SMACNA standards.
4. Expansion provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
5. Fabricate cleats and attachment devices from the same material as accessory being anchored or from compatible, non-corrosive metal.
6. Fabricate cleats and attachment devices of sizes in accordance with SMACNA 1793, but not less than thickness of metal being secured.
7. Seams: Fabricate non-moving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by the Sealant Manufacturer for intended use.

B. Roof Drainage Sheet Metal Fabrications:
1. Prefinished parapet scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4 inch wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:
a. Aluminum-zinc alloy coated steel: 22 gauge thickness.
2. Prefinished conductor heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with built-in overflows. Fabricate from the following materials:
a. Aluminum-zinc alloy-coated steel: 22 gauge thickness.
3. Prefinished downspouts: Fabricate of dimensions and configurations as shown on the Drawings. Fabricate from the following materials:
a. Aluminum-zinc alloy-coated steel: 22 gauge thickness.

C. Low-Slope Roof Sheet Metal Fabrications:
1. Prefinished roof-edge flashing raised (gravel stop) or flat roof edge: Fabricate in minimum 96 inch long, but not exceeding 10 foot long, sections.
a. Joint style: Butt, with 12 inch wide, concealed backup plate, SMACNA 1793, Figure 2-5C at face of roof edge.
b. Fabricate from the following materials:
1) Aluminum-zinc alloy-coated steel: 22 gauge thickness.
2. Prefinished copings: Fabricate in minimum 96 inch long, but not exceeding 10 foot long sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and weld watertight.
a. Coping profile: SMACNA 1793, Figure 3-4A.
b. Joint style: SMACNA 1793, Figure 3-3, No. 18, at top of coping and in conjunction with SMACNA 1793, Figure 2-5C at face coping.
c. Fabricate from the following materials:
1) Aluminum-zinc alloy-coated steel: 22 gauge thickness.
3. Standing seam metal roof fabrications:
a. Prefinished peak, gable, eave, head wall, side wall, roof edge flashing, and prefinished gutters: Fabricate from the following materials:
1) Aluminum-zinc alloy-coated steel: 22 gauge thickness.
b. Prefinished gutters: Fabricate from the following materials:
1) Aluminum-zinc alloy-coated steel: 22 gauge thickness.

D. Solder shop formed joints except at prefinished metal. After soldering, remove flux and wash clean.

E. Pre-manufactured Coping:
1. Layout:
a. Fabricate sheet metal in as long of lengths as possible but never less than 10 feet, except at wall ends.
b. Layout seams to provide consistent lengths and layout along building length to achieve a symmetrical layout.
c. Where required to achieve a symmetrical layout, install lengths less than 10 feet as equal sections adjacent to corners.
2. Fabricate corners in mitered single units with seamless tops and minimum 18 inch long legs.

2.6 FINISHES

A. Prefinished Metal Coatings:
1. General: Prefinish, coil coat, exposed metal sheets to the greatest extent possible prior to forming and panel fabrication.
2. Fluorocarbon coating: 70% Kynar 500, consisting of proper cleaning, pretreatment and conversion coating, followed by epoxy-resin baked-on prime coat, followed by fluorocarbon coating baked 15 minutes at 450°F to produce a finish coat no less than 0.8 mil thick.
a. Color: As selected by the ENGINEER from the Manufacturer’s standards.
3. Concealed steel coating: On inside faces of steel panels, provide the Panel Manufacturer's standard rust-inhibitive coating.
4. Protective film: Transparent, color-coded, strippable-film coating, no less than 1 mil DFT, suitable for protection of the finish through completion of the erection and capable of being easily hand-stripped from the surface.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install flashing and sheet metal as shown on the Drawings and in accordance with the SMACNA 1793.
B. Install cleats and starter strips before starting the installation of sheet metal.
C. Expansion Joints in Metal Copings, Edge Flashings, and Gravel Stops:
   1. Seal expansion space between the ends of flashing sections.
   2. Apply a continuous bead of joint sealant between the cover plate and the flashing sections at each end.
D. Secure flashings with concealed fasteners where possible.
E. Fit flashings tightly, with square corners and surfaces true and straight.
F. Seam and seal field joints.
G. Install plane surfaces free from waves and buckles.
H. Separate dissimilar metals with bituminous coating or nonabsorptive gaskets.
I. Secure coping to parapet with continuous cleats at exposed building face and screws with neoprene washers at roof face. Provide screws at 8 inches on center maximum.
J. Reglets:
   1. Install reglets true to line and level. Seal the top of the surface-mounted reglet with joint sealant.
   2. Install flashings into reglets to form a tight fit. Secure with lead or plastic wedges at 9 inches on center maximum. Seal the remaining space with joint sealant.
K. Gutters: Secure with straps spaced a maximum of 36 inches on center and within 12 inches of ends.
L. Downspouts:
   1. Secure downspouts with straps spaced a maximum of 8 feet on center and within 2 feet of ends and elbows.
   2. Flash downspouts a minimum of 3 inches into gutters and conductor heads; fasten.
   3. Flash upper sections into lower sections a minimum of 2 inches at joints; fasten sections together.
M. Apply joint sealants as specified in SECTION 07 92 00.

3.2 CLEANING

A. Clean sheet metal; remove slag, flux, stains, spots, and minor abrasions without etching surfaces.

END OF SECTION

SECTION 07 72 13
MANUFACTURED ROOF CURBS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for manufactured roof curbs.

1.2 SUBMITTALS

A. Product Data: Indicate sizes, configurations, materials, and attachment.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Roof Curbs:
   1. Commercial Products Group, RPS
   2. Greenheck Fan Corporation, GPIP
   3. Thybar Corporation

2.2 MATERIALS

A. Manufactured Units:
   1. Roof curbs:
      a. Height: 12 inches, minimum or as specified on Drawings.
      b. Construction: 18 gauge galvanized steel with mitered and welded corners, integral base flange.
      c. Nailer: Nominal 2 inch by 2 inch preservative treated wood, bolted to top of curb.
      d. Insulation: Glass fiber type, 1 1/2 inches thick, applied to the inside curb surface with permanent adhesive.
      e. Reinforcement – curbs over 3 feet in length: Minimum 1 inch by 1 inch by 1/8 inch thick galvanized steel angle.
      f. Roof slope: Match the slope of the roof and provide a level mounting surface.
      g. Counterflashing: Galvanized steel, fit to the curb.
      h. Liner: 22 gauge galvanized steel.
   2. Pipe flashings:
      a. Cover: ABS plastic cover with mounting holes and molded sealing rings on the collar.
      b. Cap: Molded EPDM rubber with SST steel draw bands.

2.3 ACCESSORIES

A. Fasteners: Galvanized steel, the type best suited to the application.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions.
B. Coordinate the installation of components with the installation of roofing membrane and membrane flashings.
C. Secure rigidly to supporting construction.

END OF SECTION

INTENTIONALLY BLANK

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for joint sealants.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 510 – Standard Test Method for Staining and Color Change of Single- or Multi-component Joint Sealants
  2. C 719 – Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
  3. C 794 – Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants
  4. C 834 – Standard Specification for Latex Sealants
  5. C 920 – Standard Specification for Elastomeric Joint Sealants
  6. C 1087 – Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
  7. C 1193 – Standard Guide for Use of Joint Sealants
  8. C 1248 – Standard Test Method for Staining of Porous Substrate by Joint Sealants
  9. C 1330 – Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
  10. D 2203 – Standard Test Method for Staining from Sealants
- B. Federal Specification (FS):
  1. TT-S-001657 – Sealing Compound - Single Component, Butyl Rubber Based, Solvent Release Type (For Buildings and Other Types of Construction)

1.3 SUBMITTALS
- A. Product Data:
  1. Indicate sealants, primers, backup materials, bond breakers, and accessories proposed for use.
  2. Indicate Shore A hardness, tensile strength at break, tensile elongation, 100% modulus, tear strength, and adhesion in peel.
  3. Color charts: Provide charts for initial color selection indicating available colors.
- B. Samples:
  1. Wet samples of colors from initial selection, 1/2 inch by 1/2 inch by 3 inches long joint sealant samples, for final selection.
  2. Jong joint backup material: 6 inch.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Installation warranty.
  3. Warranty.

1.4 QUALITY ASSURANCE
- A. Applicator Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Laboratory Pre-Construction Testing:
  1. Obtain representative samples of actual substrate materials.
  2. Test sealants and accessories for the following:
     a. Adhesion: Determine the surface preparation and required primer; test in accordance with ASTM C 794 and ASTM C 719.
     b. Compatibility: Determine that materials in contact with sealants do not adversely affect sealant materials or sealant color; test in accordance with ASTM C 1087.
     c. Staining: Determine that sealants will not stain joint substrates; test in accordance with ASTM D 2203, ASTM C 510, or ASTM C 1248.
     d. Pre-construction testing is not required when the sealant Manufacturer furnishes data acceptable to the ENGINEER based on previous testing for materials matching those of the Work.
- C. Field Pre-Construction Testing: Test each joint sealant and joint substrate before beginning the Work of this Section.
  1. Install sealants in mockups using joint preparation methods and materials recommended by the Sealant Manufacturer.
  2. Install field-test joints in location as directed by the ENGINEER.
  3. Test sealants using the Manufacturer's standard field adhesion test; verify joint preparation and primer required to obtain the optimum adhesion of sealants to joint substrate.
  4. When a test indicates sealant adhesion failure, modify joint preparation and primer, or both, and retest until the joint passes sealant adhesion test.

1.5 SITE CONDITIONS
- A. Do not apply sealants at temperatures below 40°F unless approved by the Manufacturer.
- B. Do not apply sealants when precipitation is occurring, when such conditions are anticipated in the day, or when the joint to be sealed is damp, wet, or frozen.

1.6 WARRANTY
- A. Manufacturer: Standard Manufacturer’s warranty not less than 1 year from the Substantial Completion date for the satisfactory performance of the installed joint sealant material.

B. Installer: Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the joint sealant system and associated appurtenances, including correction, or at the option of the OWNER, removal and replacement of the Work found to be defective.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Joint Sealant Type 1:
1. BASF Building Systems (Master Builders), MasterSeal SL2
2. Pecora Corporation, Dynatred
3. Sika Corporation, Construction Products Division, Sikaflex 2C-SL
4. Tremco Incorporated, THC 901

B. Joint Sealant Type 2:
1. BASF Building Systems (Master Builders), MasterSeal NP2
2. Pecora Corporation, Dynatrol II
3. Sika Corporation, Construction Products Division; Sikaflex 2C-NS
4. Tremco Incorporated, Dymeric 240FC

C. Joint Sealant Type 3:
1. Pecora Corporation, BC-158
2. Tremco Inc., Butyl Sealant

D. Joint Sealant Type 4:
1. Bostik, Inc., Bosti-Flex Plus
2. Pecora Corporation, AC-20 + Silicone

E. Joint Sealant Type 5:
1. Dow Chemical Company, DOWSIL 795
2. GE Advanced Materials – Silicones, SilPruf SCS2000
3. Pecora Corporation, 864NST
4. Sika Corporation, Construction Products Division; SikaSil-WS-295
5. Tremco Incorporated, Spectrem 3

F. Joint Sealant Type 6:
1. Dow Chemical Company, DOWSIL 680
2. GE Advanced Materials – Silicones, Sanitary SCS1700
3. Tremco Incorporated, Tremsil 200 Sanitary

G. Joint Sealant Type 7:
1. ITW Polymers Sealants North America, PolySpec Thiokol 2235M
2. Pecora Corporation, Synthacalk GC-2+
3. W. R. Meadows, Inc., Deck-O-Seal Gun Grade

H. Joint Sealant Type 8:
1. Pecora AC-20 FTR
2. Tremco Inc., Acoustical Sealant

I. Joint Sealant Type 9:
1. Schul International Company, Inc., Sealtite Standard
2. Tremco Inc., illmod 600

J. Joint Sealant Type 10:
1. BASF Building Systems (Master Builders), MasterSeal CR 190
2. Bowers Industrial, CF-621
3. Sika Corporation, Sikadur 51 NS

K. Accessories:
1. Industrial Thermo Polymers Limited

2.2 MATERIALS

A. Joint Sealant Type 1:
1. Multiple-component polyurethane type, self-leveling traffic grades, in accordance with ASTM C 920, Type M, Grade P, Class 25, for Use T.
2. Movement capability: ±50%.
3. Color: To be selected from the Manufacturer's full color range.

B. Joint Sealant Type 2:
1. Multiple-component polyurethane type, non-sag, in accordance with ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
2. Movement capability: ±50%.
3. Color: To be selected from the Manufacturer's full color range.

C. Joint Sealant Type 3:
1. Single-component butyl rubber type, non-sag, in accordance with FS TT-S-001657, Type 1.
2. Movement capability: ±10%.
3. Color: To be selected from the Manufacturer's full color range.

D. Joint Sealant Type 4:
1. Single-component acrylic latex, or siliconized acrylic latex, non-sag, in accordance with ASTM C 834, Type OP, Grade NF.
2. Movement capability: ±7.5%.
3. Color: White.

E. Joint Sealant Type 5:
   1. Single-component silicone, non-sag, neutral-curing, in accordance with ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
   2. Movement capability: ±50%.
   3. Color: To be selected from Manufacturer's full color range.

F. Joint Sealant Type 6:
   1. Single-component silicone, non-sag, mildew-resistant, acid-curing in accordance with ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   2. Movement capability: ±25%.
   3. Color: To be selected from the Manufacturer's full color range.

G. Joint Sealant Type 7:
   1. Multicomponent, Non-sag, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
   2. Movement capability: ±25%.
   3. Color: To be selected from the Manufacturer's full color range.

H. Joint Sealant Type 8:
   1. Single-component acrylic latex, non-sag, non-hardening, recommended by the Manufacturer for acoustical applications, in accordance with ASTM C 834.
   2. Movement capability: ±7.5%.
   3. Color: White.

I. Joint Sealant Type 9:
   1. Compressible sealant: A foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on the front face with a non-reactive release agent.
   2. Width of material to be twice the joint width.

J. Joint Sealant Type 10: Epoxy sealant, two-part 100% solids epoxy joint fillers.

2.3 ACCESSORIES

A. Primers, Bondbreakers, and Solvents: As recommended by the Sealant Manufacturer.

B. Joint Backing:
   1. Closed-cell PE foam, preformed round joint filler, nonabsorbing, nonstaining, resilient, compatible with sealant and primer, recommended by the Sealant Manufacturer for each sealant type, in accordance with ASTM C 1330.
   2. Size: Minimum 1 1/4 times the joint width.

2.4 MIXES

A. Mix multiple-component sealants in accordance with the Manufacturer's instructions:
   1. Mix with a mechanical mixer; prevent air entrainment and overheating.
   2. Continue mixing until the color is uniform.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove loose and foreign matter that could impair adhesion. If the surface has been subject to chemical contamination, contact the Sealant Manufacturer for recommendations.

B. Clean and prime joints in accordance with the Manufacturer's instructions.

C. Protect adjacent surfaces with masking tape or protective coverings.

3.2 APPLICATION

A. Apply products in accordance with the Manufacturer's instructions.

B. Perform installation in accordance with ASTM C 1193.

C. Install joint backing to maintain required sealant dimensions. Compress backing approximately 25% without puncturing skin. Do not twist, tear, or stretch.

D. Use bondbreaker tape where joint backing is not installed.

E. Fill joints full without air pockets, embedded materials, ridges, and sags.

F. Sealant Depth: Install sealants to depths as recommended by the Sealant Manufacturer, but within the following general limitations:
   1. Sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures: Fill joints to a depth equal to 75% of joint width, but no more than 5/8 inch deep and no less than 3/8 inch deep.
   2. Normal moving joints sealed with elastomeric sealants, but not subject to traffic. Fill joints to a depth equal to 50% of joint width, but no more than 1/2 inch deep and no less than 1/4 inch deep.
   3. Joints sealed with non-elastomeric sealants: Fill joints to a depth in the range of 75% to 100% of joint width.

G. Tooling:
   1. Tool sealant to form full contact with substrate.
   2. Tool joints to form smooth, uniform beads with slightly concave surfaces.
   3. Finish joints shall be straight, uniform, smooth, and neatly finished.
   4. At horizontal joints adjacent to the vertical surface, fill the joint to form a slight cove so that the joint will not trap moisture and dirt.

H. Apply sealant within the recommended temperature range. Consult the Manufacturer when sealant cannot be applied within the recommended temperature ranges.

3.3 CLEANING

A. Remove masking tape and protective coverings after sealant has cured.

B. Clean adjacent surfaces.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 11 13.13
STANDARD HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for standard hollow metal doors and frames.

B. Related Sections:

1. SECTION 08 71 00 – DOOR HARDWARE
2. SECTION 08 80 00 – GLAZING

1.2 REFERENCES

A. American National Standards Institute/Steel Door Institute (ANSI/SDI):

1. A250.4 – Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, and Frame Anchors
2. A250.8 –Specifications for Standard Steel Doors and Frames
3. A250.10 – Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames
4. A250.11 – Recommended Erection Instructions for Steel Frames

B. ASTM International (ASTM):

1. A 568 – Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
2. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. A 924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
4. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
5. A 1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
6. C 578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
7. C 665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
8. C 1363 – Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
9. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

C. National Fire Protection Association (NFPA):

1. 80 – Standard for Fire Doors and Other Opening Protectives

D. Underwriters Laboratories (UL):

1. 10C – Standard for Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Shop Drawings:

1. Show internal door and frame reinforcement, metal thickness, anchorages, hardware reinforcement and location, and wall openings at doors and frames.
2. Door and frame elevations with the location of openings.
3. Frame sections with dimensioned profiles for each frame/wall condition.
4. Details of preparation for power and control systems.
5. Details of moldings, stops, and glazing.

B. Quality Control Submittal: Provide certification that doors and frames comply with the specified referenced standards and requirements.

C. Door Schedule for Each Opening:

1. Use the same reference numbers shown on the Drawings.
2. Identify opening location.
3. Indicate door and frame elevations, size, gauge of construction, frame section, wall anchors, swing, and fire ratings.

1.4 QUALITY ASSURANCE

A. Doors and Frames: In accordance with ANSI/SDI A250.8.

B. Fire Rated Door and Frame Construction: Label doors and frames listed in accordance with UL 10C.

C. Installed Fire Rated Door and Frame Assemblies: In accordance with NFPA 80.

D. Performance:

1. Performance test for steel doors and hardware reinforcings shall be in accordance with ANSI/SDI A250.4.
   a. The test specimen shall be a 3 feet by 7 feet nominal size 1 3/4 inch thick door.
   b. The specimen shall be tested in accordance with ANSI/SDI A250.4 for 5 million cycles, with a total of 103 twist tests conducted.
   c. Test reports shall include a description of the test specimen and the procedures used in testing and shall indicate compliance with the acceptance criteria of the test.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship doorframes with a removable angle spreader at sill; do not remove until the frame is installed.

B. Store doors upright in a protected, dry area, off the ground or the floor, with at least 1/4 inch space between individual units.

C. Do not cover with non-vented coverings that create excessive humidity.

D. Remove wet coverings immediately.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Pioneer Industries, Inc.
B. Steelcraft, Land B Series Doors
C. Stiles Custom Metal
D. West Central Manufacturing

2.2 MATERIALS

A. Steel Sheet:
   1. Cold-rolled: In accordance with ASTM A 568 or ASTM A 1008.
   2. Hot-rolled: In accordance with ASTM A 568 and ASTM A 1011.
B. Galvanized Steel Sheet: Hot-dipped, structural quality, in accordance with ASTM A 653 Class A60 or G60 or ASTM A 924.
C. Insulation:
   1. Fiberglass: 6 lb/cf to 12 lb/cf density in accordance with ASTM C 665.
   2. Polystyrene: 1 lb/cf density in accordance with ASTM C 578.
D. Primed Steel Materials: In accordance with ANSI/SDI A250.10.

2.3 COMPONENTS

A. Doors: Provide doors in accordance with ANSI/SDI A250.8:
   1. Usage classification:
      a. Exterior doors: Level 3 Extra Heavy Duty, Model 2-Seamless, face steel sheet 16 gauge galvanized steel sheet.
      b. Interior doors: Level 2 Heavy Duty, Model 2-Seamless, face steel sheet 18 gauge cold rolled steel sheet.
   2. Construction:
      a. Overall thickness of 1 3/4 inches; each face constructed from a single steel sheet.
      b. Close top and bottom edges of doors with steel channel, minimum 14 gauge, extending the full width of door, and spot welded to both faces, with the top channel flush and the bottom channel recessed.
      c. Core: Exterior thermal-resistant rated doors:
         1) Rigid polystyrene core bonded to the inside face of both panels for the full height and width of the door.
         2) Thermal characteristics: The core insulation shall have a U-factor of 0.15.
         3) Thermal performance: The door assembly shall have a U-factor of not more than 0.39, tested in accordance with ASTM C 1363, for flush hollow metal doors.
         4) Air infiltration: Doors shall have an infiltration of no more than 0.40 cfm/sf, tested in accordance with ASTM E 283.
      d. Core: Interior/non-thermal resistance rated doors:
         1) Provide continuous vertically formed 20 gauge steel section stiffeners which span the full thickness of the interior space between door faces. Space channels so interior webs are not over 6 inches apart, extending the full height of door panel and spot welded to face sheets and bonded to opposite face a maximum of 5 inches on center, constructed so as to interlock both face sheets.
         2) Fill voids between the vertical steel stiffeners with insulation.
      e. Join the vertical edge closure between the face sheets by a continuous weld, extending the full height of the door, ground and dressed smooth to provide a seamless edge.
      f. Provide edge profiles on both vertical edges of the doors as follows:
         1) Single acting doors: Beveled 1/8 inch in 2 inch profile.
         2) Double acting doors: Rounded on 2 1/8 inch radius.
   3. Hardware reinforcement:
      a. Mortise, reinforce, drill, and tap at the factory for mortised template hardware only, in accordance with the approved hardware schedule and templates provided by the Hardware Supplier. Provide reinforcing plates where surface-mounted hardware is to be applied with drilling and tapping done in the field.
      b. Provide reinforcement as follows:
         1) Hinges and pivots: 7 gauge steel, 9 inch length, welded to interior edge channels.
         2) Lock fronts and strikes: 16 gauge steel.
         3) Closers: 14 gauge steel.
   4. Glass moldings and stops: Provide doors with Manufacturer's standard steel moldings to secure glazing, in accordance with glass sizes and thicknesses shown on the Drawings.
   5. Louvers:
      a. The Manufacturer's standard inverted Y-blade type.
      b. Frames: Minimum 20 gauge steel.
      c. Blades: Minimum 24 gauge steel.
      d. Weld the blades to the frame with one molding integral with louver.
      e. Install loose molding on the secure side of the door.
B. Frames: Provide frames in accordance with ANSI/SDI A250.8:
   1. Usage classification:
      a. Exterior frames and frames over 3 feet 4 inches in width: Level 4 Maximum Duty, for use with Model 2-Seamless, minimum steel thickness 14 gauge, galvanized steel sheet.
      b. Interior frames: Level 2 Heavy Duty, for use with Model 2-Seamless, minimum steel thickness 16 gauge, cold rolled steel sheet.

2. Construction:
    a. Type: Close corner joints tight with trim faces mitered, continuously welded, and ground smooth.
    b. Hardware reinforcements:
        1) Mortise, reinforce, drill, and tap at the factory for mortised template hardware only, in accordance with the approved hardware schedule and templates provided by the Hardware Supplier. Provide reinforcing plates where surface-mounted hardware is to be applied, with drilling and tapping one in the field.
        2) The minimum thickness of hardware reinforcing plates:
            a) Hinge and pivot reinforcement: 7 gauge.
            b) Lock reinforcements: 16 gauge.
            c) Closer reinforcements: 14 gauge.
            d) Reinforcements for other surface-applied hardware: 12 gauge.
            e) Provide galvannealed reinforcements at exterior frames.
    c. Electrical requirements:
        1) Provide coordination for electrical requirements for doors and frames. Make provisions for the installation of electrical items, for the removal/replacement of wiring.
            a) Provide cutouts and reinforcements required for doors and frames to accept electric and security components.
    d. Anchors:
        1) Provide one anchor at each jamb for each 30 inches of door height.
        2) Design anchors to provide positive fastenings to adjacent construction.
        3) Provide one floor anchor welded to each jamb.
    e. Where frames will be filled with concrete or grout, install silencers in the frames before erection.

2.4 ACCESSORIES

A. Glass, Glazing Sealers, and Accessories: As specified in SECTION 08 80 00.

B. Glazing Stops:

1. The Manufacturer's standard screw on type with butt joints.
2. Form stops from 20 gauge steel at a minimum; pre-fit for field glazing.
3. Locate screws within 1 inch of the ends of stops and at a maximum of 8 inches on center.
4. Install glazing stops on the secure side of the frames.

2.5 FABRICATION

A. Accurately form to the required sizes and profiles.

B. Grind and dress exposed welds to form smooth, flush surfaces.

C. Do not use metallic filler to conceal manufacturing defects.

D. Fabricate with internal reinforcement for hardware as specified in SECTION 08 71 00; weld in place.

E. Fabricate doors and frames to maintain the following clearances:

1. Between the door and the frame: 1/8 inch.
2. Between meeting edges of pairs of doors (non-fire rated): 3/16 inch, ±1/16 inch.
3. Between meeting edges of pairs of fire rated doors: 1/8 inch, ±1/16 inch.
4. Between the bottom of door and the bottom of frame (non-fire rated): 3/4 inch maximum.
5. Between the bottom of the door and bottom of the frame of fire rated doors: In accordance with NFPA 80.
6. Between the face of door and the stop: 1/16 inch.

2.6 FINISHES

A. Dress tool marks and surface imperfections to smooth surfaces.

B. Chemically treat and clean.

C. Exterior Doors and Frames: Provide zinc coating applied by the hot-dip process in accordance with ASTM A 653, Class A60 or G60.

D. Other Doors and Frames: Apply the Manufacturer's standard primer paint to exposed surfaces with rust inhibiting primer with 3 days to 7 days of dry time prior to shipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install doors and frames in accordance with ANSI/SDI A250.11.

B. Install fire rated doors and frames in accordance with NFPA 80.

C. Set plumb, level, true, and in alignment.

D. Secure to adjacent construction using the anchor type best suited to the application.

E. Install glass as specified in SECTION 08 80 00.

F. Install hardware as specified in SECTION 08 71 00.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions to match the factory finish.

B. Adjust doors for proper operation.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 11 13.19
COMMERCIAL HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for commercial hollow metal doors and frames.

B. Related Sections:

1. SECTION 08 71 00 – DOOR HARDWARE
2. SECTION 08 80 00 – GLAZING

1.2 REFERENCES

A. American National Standards Institute/Steel Door Institute (ANSI/SDI)

1. A250.10 – Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames

B. ASTM International (ASTM)

1. A 568 – Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
2. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. A 924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
4. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
5. A 1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
6. C 578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
7. C 665 – Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

C. National Association of Architectural Metal Manufacturers (NAAMM):

1. HMMA 830 – Hardware Selection for Hollow Metal Doors and Frames
2. HMMA 831 – Hardware Locations for Hollow Metal Doors and Frames
3. HMMA 840 – Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames
4. HMMA 861 – Guide Specifications for Commercial Hollow Metal Doors and Frames

D. National Fire Protection Association (NFPA):

1. 80 – Standard for Fire Doors and Other Opening Protectives

E. Underwriters Laboratories (UL)

1. 9 – Fire Tests of Window Assemblies
2. 10C – Standard for Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Shop Drawings:

1. Show internal door and frame reinforcement, metal thickness, anchorages, hardware reinforcement and location, and wall openings at doors and frames.
2. Door and frame elevations with the location of openings.
3. Frame sections with dimensioned profiles for each frame/wall condition.
4. Details of preparations for power and control systems.
5. Details of moldings, stops, and glazing.

B. Quality Control Submittals: Provide certification that doors and frames comply with specified referenced standards.

C. Door Schedule for Each Opening:

1. Use the same reference numbers as those shown on the Drawings.
2. Identify the opening location.
3. Indicate door and frame elevations, size, and gauge of construction, frame section, wall anchors, swing, and fire ratings.

1.4 QUALITY ASSURANCE

A. Doors and Frames: Fabrication, physical endurance, and quality in accordance with NAAMM HMMA 861 and hardware preparation and installation in accordance with NAAMM HMMA 830, unless other specific requirements are noted.

B. Fire Rated Door and Frames:

1. Provide doors and frames tested as an assembly in accordance with UL 10C and bearing the label of a testing agency with a factory inspection service indicating the applicable fire rating of both the door and the frame.
2. Install fire rated door and frame assemblies in accordance with NFPA 80.

C. Fire Rated Window Frames in Doors: Provide doors and frames tested as an assembly in accordance with UL 9 and bearing the label of a testing agency with a factory inspection service indicating the applicable fire rating of both the door and the frame.

D. Finish Performance: Primer paint performance in accordance with ANSI/SDI A250.10.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship door frames with a removable angle spreader at sill; do not remove until the frame is installed.

B. Store doors upright in a protected, dry area, off the ground or floor, with at least a 1/4 inch space between individual units.

C. Do not cover with non-vented coverings that create excessive humidity.

D. Remove wet coverings immediately.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Southwestern Hollow Metal
B. Stiles Custom Metal
C. West Central Manufacturing

2.2 MATERIALS

A. Steel Sheet:
   1. Cold-rolled: In accordance with ASTM A 568 or ASTM A 1008.
   2. Hot-rolled: In accordance with ASTM A 568 or ASTM A 1011.
B. Galvanized Steel Sheet: Hot-dipped, structural quality, in accordance with ASTM A 653, Class A60 or G60 or ASTM A 924.
C. Insulation:
   1. Fiberglass: 6 lb/cf to 012 lb/cf density, in accordance with ASTM C 665.
   2. Polystyrene: 1 lb/cf density, in accordance with ASTM C 578.

2.3 COMPONENTS

A. Doors:
   1. Construction:
      a. Overall thickness of 1 3/4 inches of the sizes and types shown on the Drawings.
      b. Interior doors: Face sheet steel 16 gauge minimum thickness.
      c. Exterior doors:
         1) Face sheet steel 14 gauge minimum thickness.
         2) Finish: Zinc coating applied by the hot-dip process in accordance with ASTM A 653, Class A60 or G60.
      d. Provide continuous vertically formed 20 gauge steel section stiffeners which span the full thickness of the interior space between door faces. Space channels so interior webs are not over 6 inches apart, extending the full height of door panel and spot welded to face sheets a maximum of 5 inches on center, constructed so as to interlock both face sheets.
      e. Close the top and the bottom edges of doors with steel channel, minimum 16 gauge, extending the full width of the door, and spot welded to both faces with the top channel flush and the bottom channel recessed. Where required for attachment for weatherstripping, provide a flush closure channel at the bottom edge. Provide openings in the bottom closure of the exterior doors to permit the escape of entrapped moisture.
      f. Join the vertical edge closure between the face sheets by a continuous weld, extending the full height of the door, ground and dressed smooth to provide a seamless edge.
      g. Provide continuous reinforcing of the vertical edge closure with a material that is the same thickness as the door faces, extending the full height of the door, and welded to the top and the bottom closing channels to produce a fully welded perimeter reinforcement.
      h. Provide edge profiles on both vertical edges of doors as follows:
         1) Single acting doors: Beveled 1/8 inch in 2 inch profile.
         2) Double acting doors: Rounded on 2 1/8 inch radius.
      i. Insulation:
         1) Fill voids between the vertical stiffeners with fiberglass insulation for a U-value not to exceed 0.19.
         2) For thermal-resistance-rated exterior doors, fill voids in the core with polystyrene or cotton batt insulation for a U-value not to exceed 0.17.
   2. Hardware reinforcement:
      a. Mortise, reinforce, drill, and tap at the factory for mortised template hardware only, in accordance with the approved hardware schedule and templates provided by the Hardware Supplier. Provide reinforcing plates where surface-mounted hardware is to be applied with drilling and tapping done in the field.
      b. Provide reinforcement as follows:
         1) Hinges and pivots: 7 gauge steel, 9 inch length, welded to interior edge channels.
         2) Lock fronts, strikes, concealed holders, or surface-mounted closers: 12 gauge steel welded to interior edge channels.
         3) Other surface-applied hardware: 14 gauge steel.
   3. Glass moldings and stops:
      a. Provide doors with steel moldings to secure glazing, in accordance with glass sizes and thicknesses shown on the Drawings.
      b. Fixed frame molding: Formed integral with hollow metal frame, 5/8 inch height.
      c. Removable glass stops: Channel shaped no less than 20 gauge thickness with tight fitting mitered corner joints of the same material as the doors and frames.
      d. Chemically treat the inside of the glazing stops and the metal surfaces which the glazing stops are secured to for maximum paint adhesion and paint with a rust-inhibitive primer prior to installation.
   4. Louvers:
      a. Manufacturer's standard, inverted Y-blade type.
      b. Frames: Minimum 20 gauge steel.
      c. Blades: Minimum 24 gauge steel.
      d. Weld blades to the frame with one molding integral with louver.
      e. Install loose molding on the secure side of the door.

B. Frames:
1. Provisions of this Section are applicable to door frames, transom frames, sidelights, and window assemblies.
2. Construction:
a. Frame units of the sizes and types shown on the Drawings, with integral stops.
b. Interior openings:
1) Door openings 4 feet or less in width and window frames: Minimum steel thickness, 16 gauge.
2) Door openings greater than 4 feet in width: Minimum steel thickness, 14 gauge.
c. Exterior openings:
1) Frame: Minimum steel thickness, 14 gauge.
2) Finish: Zinc coating applied by the hot-dip process in accordance with ASTM A 653 Class A60 or G60.
d. Close corner joints tightly with trim faces mitered, continuously welded, and ground smooth. Other face joints shall be continuously welded and smoothly finished.
e. Hardware reinforcements:
1) Mortise, reinforce, drill, and tap at the factory for mortised template hardware only, in accordance with the approved hardware schedule and templates provided by the Hardware Supplier. Provide reinforcing plates where surface-mounted hardware is to be applied, with drilling and tapping done in the field.
2) The minimum thickness of hardware reinforcing plates:
a) Hinge and pivot reinforcement: 7 gauge by 1 1/4 inches by 10 inch length.
b) Strike reinforcements: 12 gauge.
c) Closer reinforcements: 12 gauge.
d) Flush bolt reinforcements: 12 gauge.
e) Reinforcements for surface-applied hardware: 12 gauge.
f) Reinforcements for hold-open arms: 12 gauge.
g) Reinforcements for surface panic devices: 12 gauge.
f. Floor anchors:
1) Steel clip angles of a minimum of 14 gauge thickness formed from the same material as the frame.
2) Provide with two holes for fasteners and weld inside jambs with a minimum of four spot welds per anchor.
3) At door sidelights and locations where floor anchors cannot be installed, provide a continuous 14 gauge sub-channel secured to the floor to prevent the movement of the frame at the sill; provide a 3 inch high vertical leg of channel at 4 inch high sill frames and a 1 inch high vertical leg of channel at 2 inch high sill frames.
g. Jamb anchors:
1) Masonry type: Strap and stirrup type with adjustable jamb anchors, minimum 16 gauge thickness; strap size, minimum 2 inch by 10 inch corrugated or perforated, placed a maximum of 10 inches from the top and the bottom of openings; provide the minimum number of anchors spaced at 32 inches on center maximum on each jamb based on frame opening height as follows:
a) Up to 60 inches: Three anchors.
b) Greater than 60 inches and up to 90 inches: Four anchors.
c) Greater than 90 inches and up to 96 inches: Five anchors.
d) Greater than 96 inches: Six anchors plus one for each 24 inches, or fraction thereof, over 96 inches.
2) Gypsum board type: Steel anchors of suitable design, minimum 18 gauge thickness, welded inside each jamb, placed a maximum of 18 inches from top and bottom of openings; provide the minimum number of anchors spaced at 32 inches on center maximum on each jamb based on frame opening height as follows:
a) Up to 60 inches: Three anchors.
b) Greater than 60 inches up to 90 inches: Four anchors.
c) Greater than 90 inches up to 96 inches: Five anchors.
d) Greater than 96 inches: Five anchors plus one for each 24 inches, or fraction thereof, over 96 inches.
3) Bolt type: Expansion anchors for installation in existing masonry or concrete walls. Provide a countersunk hole for a 1/2 inch diameter bolt and a spacer from the unexposed surface of the frame to the wall, welded to the frame. Place spacers a maximum of 6 inches from the top and the bottom of the door opening, with intermediate spacing at a maximum of 18 inches on center.
h. Head stiffeners:
1) Provide for frames installed in masonry or concrete wall openings that are more than 4 feet in width.
2) Steel angle or channel stiffener: 12 gauge in thickness factory welded into the head for the width of the frame.
i. Plaster guards: Form from steel that is a minimum 26 gauge thick and attached at hardware mortises on frames to be set in masonry or concrete openings.
j. Where frames will be filled with concrete or grout, install silencers in frames before erection.

2.4 ACCESSORIES
A. Glass, Glazing Sealers, and Accessories: As specified in SECTION 08 80 00.

2.5 FABRICATION
A. Accurately form to required sizes and profiles.
B. Grind and dress exposed welds to form smooth, flush surfaces.
C. Do not use metallic filler to conceal manufacturing defects.
D. Fabricate with internal reinforcement for hardware as specified in SECTION 08 71 00; weld in place.

E. Tolerances: Fabricate hollow metal work to tolerances in accordance with NAAMM HMMA 861.

2.6 FINISHES

A. Dress tool marks and surface imperfections to smooth surfaces.
B. Chemically treat and clean.
C. Apply the Manufacturer's standard primer paint to exposed surfaces with rust-inhibiting primer with a minimum of 3 days to 7 days dry time prior to shipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install doors and frames in accordance with NAAMM HMMA 840.
B. Check doors and frames and correct as necessary for size, swing, squareness, alignment, twist, and plumbness. Permissible installation tolerances shall not exceed the following:
    1. Squareness: ±1/16 inch measured on a line, 90 degrees from one jamb, at the upper corner of the frame at the other jamb.
    2. Alignment: ±1/16 inch measured on jambs on a horizontal line parallel to the plane of the wall.
    3. Twist: ±1/16 inch measured at the face corners of jambs on parallel lines perpendicular to the plane of the wall.
    4. Plumbness: ±1/16 inch measured on the jamb at the floor.
C. Install fire rated doors and frames in accordance with NFPA 80.
D. Set plumb, level true, and in alignment.
E. Secure to adjacent construction using the anchor type best suited to the application.
F. Maintain proper door clearances.
G. Install glass as specified in SECTION 08 80 00.
H. Install hardware in accordance with the Manufacturer's templates and instructions and as specified in SECTION 08 71 00.
I. Clearances and Tolerances:
    1. Edge clearances for swinging doors shall not exceed the following:
        a. Between doors and frames at head and jambs: 3/16 inch.
        b. Between edges of pairs of doors: 3/16 inch.
        c. At door sills where a threshold is used: 3/8 inch from bottom of door to top of threshold.
        d. At door sills where no threshold is used: 3/4 inch.
        e. Between door bottom and nominal surface of floor coverings at fire rated openings in accordance with NFPA 80: 1/2 inch.
            1) A finished floor is defined as the top surface of the floor, except when resilient tile or carpet is used, at which point it is the top of the concrete slab.
    2. Manufacturing tolerance shall be maintained within the following limits:
        a. Frames for single door or pair of doors:
            1) Width, measured between rabbets at the head: Nominal opening width +1/16 inch -1/32 inch.
            2) Height (total length of jamb rabbet): Nominal opening height ±3/64 inch.
            3) Cross-sectional profile dimensions:
                a) Face: ±1/32 inch.
                b) Stop: ±1/32 inch.
                c) Rabbet: ±1/32 inch.
                d) Depth: ±1/32 inch.
                e) Throat: ±1/16 inch; frames overlapping walls to have a throat dimension of 1/8 inch greater than the dimensioned wall thickness to accommodate irregularities in the wall construction.
        b. Doors:
            1) Width: ±3/64 inch.
            2) Height: ±3/64 inch.
            3) Thickness: ±1/16 inch.
        c. Hardware:
            1) Cutout dimensions: Template dimensions +0.015 inch -0 inch.
            2) Location: ±1/32 inch.
J. Hardware Locations:
    1. In accordance with NAAMM HMMA 831.
    2. The location of hardware on doors and frames shall be as listed herein. Note that all dimensions except the hinge locations are referenced from the finished floor.
        a. When hollow metal frames only are specified for use with doors to be furnished by others, hardware preparation on the doors is normally governed by its location on the frames as specified in this Section. If doors are to be factory mortised, the Door Supplier is responsible for coordinating hardware locations; if mortised at the jobsite, the proper hardware location is the responsibility of the trade doing the Work.
    3. Hinges:
        a. Top: 5 inches from the frame head to the top of the hinge.
        b. Bottom: 10 inches from the finished floor to the bottom of the hinge.
        c. Intermediate: Centered between top and bottom hinges.
        d. On dutch doors: 5 inches from the head of the frame to the top of the hinge; 10 inches from the finished floor to the bottom of the bottom hinge; 5 inches from the split line to the top and the bottom, respectively, of the lower and the upper intermediate hinges.
        e. Unit and integral type locks and latches: 8 inches to centerline of the knob.

f. Deadlocks: 46 inches to centerline of the cylinder.
g. Panic hardware: 38 inches to centerline of the cross bar or as shown on the hardware template.
h. Door pulls: 42 inches to center of the grip.
i. Push/pull bars: 42 inches to centerline of the bar.
j. Arm pulls: 46 inches to centerline.
k. Push plates: 46 inches to centerline of the plate.
l. Roller latches: 45 inches to centerline of the plate.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions in primer paint to match the factory finish.
B. Adjust doors for proper operation.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 14 00
WOOD DOORS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for wood doors.
- B. Related Sections:
  1. SECTION 08 71 00 – DOOR HARDWARE

1.2 REFERENCES
- A. American National Standards Institute (ANSI):
  1. A208.1 – Particleboard
- B. Door and Hardware Institute (DHI):
  1. WDHS-3 – Recommended Hardware Locations for Wood Flush Doors
- C. National Fire Protection Association (NFPA):
  1. 80 – Standard for Fire Doors and Other Opening Protectives
  2. 252 – Standard Methods of Fire Tests of Door Assemblies
- D. Underwriters Laboratories (UL):
  1. 10C – Standard for Positive Pressure Fire Tests of Door Assemblies
- E. Window and Door Manufacturers Association (WDMA):
  1. I.S.1-A – Interior Architectural Wood Flush Doors
  2. TM 6 – Adhesive Durability

1.3 SUBMITTALS
- A. Product Data: Indicate door core materials and construction; veneer species, type, and characteristics, and window glazing and stop details.
- B. Shop Drawings:
  1. Door schedule: Use the same reference numbers shown on the Drawings. Indicate the location, size, and hand of each door as well as the elevation of each kind of door.
  2. Indicate location and extent of hardware blocking.
  3. Indicate dimensions and locations of mortises and holes for hardware.
  4. Indicate dimensions and locations of cutouts.
  5. Indicate requirements for veneer matching.
  6. Indicate doors to be factory-finished and finish requirements.
  7. Indicate fire ratings for fire doors.
- C. Samples:
  1. Color charts for initial selection showing the available colors.
  2. Wood veneer samples in each species and finish: 8 inches by 10 inches.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Quality Standard: In accordance with WDMA I.S.1-A.
- B. Fire Rated Doors:
  1. Provide doors in accordance with NFPA 80, bearing the label of a testing agency with a factory inspection service indicating the applicable fire rating.
  2. Door rating based on testing in accordance with NFPA 252 and UL 10C.
- C. Source Limitations: Obtain flush wood doors through one source from a single Manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver, store, protect, and handle products in accordance with WDMA I.S.1-A.
- B. Package doors individually and wrap bundles of doors.
- C. Do not store in damp or wet areas.
- D. Protect doors with wood species that are light sensitive from exposure to natural and artificial light after delivery.
- E. Protect the materials of this Section before, during, and after installation.

1.6 SITE CONDITIONS
- A. Environmental Requirements: Interior spaces shall be enclosed and weathertight, with wet work complete and dry. The HVAC system shall be complete and operable and maintain ambient temperature conditions prior to delivery of the doors.
- B. Acceptable humidity range: 25% to 55%.

1.7 WARRANTY
- A. Manufacturer: Provide a lifetime warranty from the Substantial Completion date for the satisfactory performance and installation of the wood door system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Masonite Architectural, Aspiro Series Marshfield-Algoma, Extra Heavy Duty Particleboard Core A-PC-B-EHD-NR/ Fire-Resistant Mineral Core A-MC-B-FR60
- B. Oshkosh Door Company, Extra Heavy Duty GPEHD 5-Ply Particleboard Core, GF 5-Ply Mineral Core
- C. VT Industries, Inc., Architectural Heritage Series 5502H PC-5/5P45H FD-60-PP5

2.2 COMPONENTS

A. Door Construction – General:
   1. Performance standard, WDMA I.S.1-A:
      a. Grade: WDMA Premium grade with Grade A faces.
      b. Construction: WDMA Extra Heavy Duty Performance Level.
   2. Doors for transparent finish:
      a. Wood veneer species and cut: Cherry, plain sliced.
      b. Match between veneer leaves: Book match.
      c. Assembly of spliced veneers: Balance match.
      d. Pair and set match: Provide for doors hung in the same opening or separated only by mullions.
      e. Door with transom: Continuous match.
   3. Stiles: Faces that are the same as, or compatible with, the species.
   4. Construction: Five plies with stiles and rails bonded to the core, then abrasive plane the entire unit before veneering.
   5. Fire rated doors: Positive pressure Category A (concealed intumescent).

B. Solid Core Doors:
   1. Non-fire rated wood doors:
      a. Core: Particleboard in accordance with ANSI A208.1, Grade LD-2.
      b. Edge: The Manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance.
   2. Fire rated wood doors – 20 minute:
      a. Core: Particleboard in accordance with ANSI A208.1, Grade LD-2.
      b. Edge: The Manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance and as required by the Manufacturer to permit positive pressure S-label in accordance with Category H.
      c. Twenty-minute fire rated pairs: Provide with fire-retardant stiles matching face veneer that are labeled and listed for the kinds of applications shown on the Drawings without formed-steel edges and astragals.
   3. Fire rated wood doors – 45-minute and longer:
      a. Core: The Manufacturer's standard mineral-core construction as needed to provide the fire rating shown on the Drawings.
      b. Edge: The Manufacturer's standard laminated-edge construction with improved screw-holding capability and split resistance that are labeled and listed to provide the fire rating shown on the Drawings.
      c. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of the fire ratings shown on the Drawings as needed to eliminate through-bolting hardware for surface-applied hardware.

2.3 ACCESSORIES

A. Glazing Stops:
   1. Non-fire rated and 20-minute fire rated wood doors: Wood, the same as, or compatible with, the door species.
   2. Fire rated for 45 minutes or longer: Flush, wood veneer clad PVC, the same as, or compatible with, the door facing.

B. Light Frames:
   1. Metal frames for light openings in fire-rated doors: The Manufacturer's standard frame formed of 0.048 inch thick, cold-rolled steel sheet; with baked enamel or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

C. Glazing: The glazing in wood doors shall be installed by the Wood Door Manufacturer.

2.4 FABRICATION

A. Fitting: Factory fit doors to suit the frame opening sizes, with the following uniform clearances and bevels:
   1. WDMA pre-fit clearances of the referenced quality standard for factory fit doors.
   2. Fire rated doors in accordance with NFPA 80.
   3. The Manufacturer's hardware templates.

B. Machining:
   1. Factory machine doors for hardware that is not surface applied.
   2. Locate hardware in accordance with DHI WDHS.
   3. Comply with final hardware schedules, door frame Shop Drawings, and hardware templates; coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

C. Openings: Cut and trim openings through the doors in the factory to comply with the applicable requirements of the referenced standard for the kind of doors required.
   1. Light openings: Trim openings with moldings of the material and profile shown on the Drawings.

D. Apply appropriate labels for applicable door fire rating.

2.5 FINISHES

A. General: In accordance with WDMA I.S.1-A finish requirements.

B. Finish doors at the factory.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: UV cured polyurethane, equivalent to WDMA TM-6.
   3. Staining: As selected from the Manufacturer's standard colors.
   4. Sheen: Satin.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine the doors and the installed frames before hanging the doors:
   1. Verify that frames comply with the requirements for type, size, location, and swing characteristics and are installed with level heads and plumb jambs.
   2. Reject doors with defects prior to hanging.

B. Proceed with installation only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install doors in accordance with the Manufacturer's instructions, the referenced quality standard, and as shown on the Drawings.

B. Hardware: Installation as specified in SECTION 08 71 00.

C. Install fire rated doors in corresponding fire rated frames in accordance with NFPA 80.

D. Align doors for uniform clearance at each edge.

E. Factory-finished doors: Restore finish before installation if fitting or machining is required at the site.

3.3 ADJUSTING

A. Operation: Adjust doors to swing and operate freely.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 31 00
ACCESS DOORS AND PANELS FOR WALLS AND CEILINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for access doors and panels for walls and ceilings.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 480 – Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
  2. A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  3. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- B. Underwriters Laboratories (UL):
  1. 10B – Standard for Fire Tests of Door Assemblies

1.3 SUBMITTALS
- A. Product Data: Provide sizes, types, finishes, scheduled locations, and details of adjoining Work.

1.4 QUALITY ASSURANCE
- A. Fire Door Construction: In accordance with UL 10B.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. General Purpose Doors for use in Masonry, Tile, and Gypsum Board Walls/Ceilings:
  1. Babcock Davis, Architectural Access Door BNT
  2. J.L. Industries, Model TM
  3. Karp Associates Inc., Model DSC 214M
  4. Milcor, Style M
  5. Nystrom Building Products, Architectural Access Door NT
- B. Fire Rated Doors:
  1. Babcock Davis, Insulated Fire Rated Access Door
  2. J.L. Industries, Model FD
  3. Karp Associates, Inc., Model KRP 150FR
  4. Milcor, Model UFR
  5. Nystrom Building Products, Insulated Fire-Rated Access Door

2.2 MATERIALS
- A. Steel Sheet: Cold-rolled, in accordance with ASTM A 1008.
- B. SST: Rollable temper, in accordance with ASTM A 480 or ASTM A 666, Type 304 or Type 316.

2.3 FABRICATION
- A. Size: Provide the size required to access mechanical, plumbing, or electrical equipment as shown on the Drawings.
- B. General Purpose Doors for Use in Masonry, Tile, and Gypsum Board Walls/Ceilings:
  1. Fabricate the doorframe of steel sheet, a minimum of 16 gauge.
  2. Fabricate the door panels of steel sheet, a minimum of 16 gauge.
  3. Hardware:
     a. Concealed spring hinge, 175 degree opening.
     b. Screwdriver-operated cam latch.
- C. Fire Rated Doors:
  1. Fabricate the door frame of steel sheet, a minimum of 16 gauge.
  2. Fabricate the fire rated door panels of two sheets of steel, a minimum of 20 gauge; fill the core with noncombustible insulation.
  3. Rating: Rating 1 1/2 hour, temperature rise 30 minutes, 250°F maximum.
  4. Hardware:
     a. Continuous hinge.
     b. Self-latching.
- D. Weld, fill, and grind joints to a flush and square appearance.

2.4 FINISHES
- A. Exterior Doors and Interior Doors in Wet Locations: SST, No. 4 satin.
- B. Interior Doors: One coat rust-inhibiting primer paint, sprayed and baked.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Install units in accordance with the Manufacturer's instructions.
- B. Install plumb and level in openings. Secure rigidly in place.
- C. Position units as shown on the Drawings or where required to provide convenient access to concealed Work requiring maintenance.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 31 01
ACCESS HATCHES AND DOORS FOR ROOF ACCESS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for access hatches and doors for roof access.

B. Related Sections:

1. SECTION 03 15 05 – ANCHORING TO CONCRETE
2. SECTION 05 50 00 – METAL FABRICATIONS
3. SECTION 07 92 00 – JOINT SEALANTS
4. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. ASTM International (ASTM):

1. A 48 – Standard Specification for Gray Iron Castings
2. A 536 – Standard Specification for Ductile Iron Castings
3. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
4. B 632 – Standard Specification for Aluminum-Alloy Rolled Tread Plate

B. American Association of State Highway Transportation Officials (AASHTO):

1. LRFD Bridge Design Specifications

1.3 SUBMITTALS

A. Product Data:

1. Hatch/door: Materials, finishes, hardware, and accessories.
2. Supplemental installation materials.

B. Manufacturer's Installation Instructions.

C. Shop Drawings: Indicate locations, dimensions, materials, finishes, attachments, and relationship to adjacent construction.

D. Warranty Documentation:

1. Sample warranty.
2. Warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

B. Performance Criteria.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and store products in the Manufacturer's original packaging until ready for installation.

B. Inspect the product upon receipt and report damaged material immediately to the delivery carrier and note damage on the carrier's freight bill of lading.

C. Store materials in a dry, protected area above grade.

D. Aluminum frames may expand and contract due to temperature. Store indoors until ready to install.

E. Support large frames and covers to prevent bending or warping during transport and handling.

F. Flush mounted style hatches contain spring-loaded latches. Follow the Manufacturer's safety instructions to prevent an accidental release of the latch.

1.6 WARRANTY

A. Manufacturer Warranty: Warranty for 5 years from the Substantial Completion date for the satisfactory performance and installation of the access hatch and door system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Curb Mounted (Roof-Style) Access Hatches and Doors:

1. Babcock-Davis
2. Bilco Company
3. Nystrom, Inc.

B. Flush Mounted Access Hatches and Doors, Non-Airport:

1. Babcock-Davis
2. Bilco Company
3. Milcor Company
4. Nystrom, Inc.

C. Airport Rated Hatches:

1. Cavotec Dabico, DAB-38WP
2. EJ, 8190 Series
3. Neenah Foundry Company, R-3498

D. Ladder Extension:

1. Babcock-Davis, Safety Post, Ladder Access
2. Bilco Company, LadderUP Safety Post, Model LU-1
3. Nystrom, Inc.

E. Safety Grate:

1. Bilco Company, fall protection grating
2. Babcock-Davis, safety grate
3. Nystrom, Inc.

2.2 MATERIALS

A. Hatches/Doors:
   1. Aluminum:
      a. Aluminum sheet/extrusion: In accordance with ASTM B 209, alloy 3003 or alloy 6061.
      b. Aluminum diamond plate in accordance with ASTM B 632.
   2. DI: In accordance with ASTM A 536 Grade 80-55-06 and ASTM A536 Grade 70-50-05 (frames only).
   3. Gray iron: In accordance with ASTM A 48, Class 35B (frames only).

B. Curb Mounted (Roof-Style) Hatches and Doors:
   1. Performance criteria:
      a. Thermally broken cover and curb to prevent heat transfer between interior and exterior surfaces.
      b. Cover operation smooth and easy with controlled operation throughout the entire arc of opening and closing.
      c. Cover operation shall not be affected by temperature.
      d. Weathertight.
      e. Maximum deflection of 1/150 of the span under the design load.
      f. Fully welded corners on cover and curb.
   2. Cover:
      a. 11 gauge aluminum (0.907 inch) sheet.
      b. Reinforced to support the following loadings:
         1) Live load of 40 psf.
         2) Wind uplift of 20 psf.
      c. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation.
      d. Continuous rubber gasket bonded to the interior of the cover to ensure a continuous seal when compressed to the top surface of the curb.
      e. Insulation: 3 inch thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m^{2}K), fully covered and protected by an 18 gauge (0.0403 inch) aluminum liner.
   3. Curb:
      a. 11 gauge (0.0907 inch) aluminum sheet.
      b. 12 inches high.
      c. Interior and exterior surfaces thermally broken to minimize heat transfer and to resist condensation.
      d. Integral mounting flange with predrilled holes.
      e. Curb insulation: 3 inch thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m^{2}K).
      f. Cap flashing: 11 gauge (0.0907 inch) aluminum sheet integral with curb.
   4. Lifting mechanism:
      a. Compression spring operators enclosed in telescopic tubes for open/closing assistance.
   5. Hardware:
      a. Hardware shall be SST.
      b. Pintle hinges shall be heavy duty.
      c. Cover equipped with a spring latch with interior and exterior turn handles.
      d. Cover automatic lock in the open position with a rigid hold open arm equipped with a 1 inch (25 mm) diameter red vinyl grip handle to permit release for closing.
      e. Cover hardware bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
   6. Handle:
      a. Provide a plain handle with no hasp or padlock on the lid.
      b. The OWNER shall weld a box around the handle and install a lock design to secure the hatch.
   7. Finish: Mill finish aluminum.

C. Flush Mounted (Floor Door Style) Hatches and Doors:
   1. Performance criteria:
      a. Cover operation smooth and easy with controlled operation throughout the entire arc of opening and closing.
      b. Cover operation shall not be affected by temperature.
      c. Maximum deflection of 1/150 of the span under the design load.
      d. Minimum live load rating:
         1) Pedestrian: 300 psf.
         2) Vehicular (off-street use): AASHTO HL-93(HS-20).
      e. Drainable, unless otherwise shown on the Drawings.
      f. Weathertight.
   2. Cover/door:
      a. 1/4 inch thick reinforced aluminum tread plate.
      b. Slam latch with fixed interior and removable exterior turn handles.
   3. Frame:
      a. 1/4 inch extruded aluminum frame.
      b. Drainage gutter around the perimeter with a coupling to attach to interior drain.
   4. Lifting mechanism:
      a. Compression spring operators enclosed in telescopic tubes.
      b. Automatic locking hold-open arm with release handle.

5. Hardware: SST.
    a. Hinges: 1/4 inch (6 mm) diameter SST pin, designed for horizontal installation with pivoting function so the covers do not protrude into the channel frame. Hinges through bolted to the covers with tamperproof lock bolts and to the frame locknuts.
6. Mounting anchors: For substrate shown on the Drawings.
7. Locking mechanism: To be provided by the OWNER.
8. Finish:
    a. Mill finish aluminum.
    b. Bituminous coating applied to the exterior of the frame for aluminum surfaces in contact with cementitious or dissimilar metals.

D. Airport Rated Hatches:
1. Performance criteria:
    a. Spring assisted hatches.
    b. Rated for airport use.
2. Cover:
    a. DI.
    b. Designed for casting into concrete.
    c. Identification: Lettering shall be 2 inches high and 1/16 inch deep and shall consist of the word WATER in capital letters.
3. Frame: DI or gray iron.
4. Latch:
    a. Slam latch.
    b. Handle has no above grade protrusions.
    c. Dual latches, activated by operating only one latch.
5. Opening mechanism:
    a. Open to a 90 degree position with a maximum 25 lb pull; close with a minimum 50 lb push.
    b. Hold-open bar to automatically lock in full-open position and release with one-hand operation.
6. Finish (airport requirements):
    a. Cover shall have a two-part coating system as specified in SECTION 09 90 00, System No. 7, Denver International Airport – vault and manhole covers.
    b. Cover top coating coloration:
        1) Blue (Pantone 292C) on the entire exterior of the hatch except for perimeter trim.
        2) Orange (Pantone 138C) in a 4 inch wide strip around the perimeter of the hatch.

2.3 ACCESSORIES

A. Ladder Extension: 42 inches high, telescoping steel tube, automatically locking when extended.
B. Mounting Hardware (if not furnished by the Manufacturer):
1. SST.
2. Expansion anchors for attachment to concrete shall be as specified in SECTION 03 15 05.

C. Access Door Handrail Assembly:
1. Mounting plates for access door and handrail:
    a. 3/8-inch steel mounting plate, galvanized.
    b. Dimensions: As shown on the Drawings.
2. Handrail and gate assembly:
    a. 1 1/2 inch diameter steel pipe handrail.
    b. Dimensions: As shown on the Drawings.
    c. Fabricate as specified in SECTION 05 50 00.

D. Safety Grate:
1. For floor access doors, where indicated on plans.
2. Panels shall be aluminum with a powder coat paint finish.
3. Stainless hold open to lock the cover in the fully open 90 degree position.
4. Hardware: SST.

E. Sealant Material (mounting to concrete):
1. Flexible gasket material.
2. Type 2 joint sealant, as specified in SECTION 07 92 00.

F. Drainage Piping (for drainable styles): As shown on the Drawings.
G. Locks: Provided and installed by the OWNER.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
1. Coordinate with the installation of underlying structure.
2. Install in accordance with the Manufacturer's instructions and approved Shop Drawings.

B. Verify the mounting surface at the hatch rough opening is level and free of debris.
C. As required, drill anchor bolt holes when the hatch is temporarily set in place as a template. Redrilling of holes or enlarging of holes is not permitted.
D. Confirm unit is plumb, level, and square prior to final fastening. If the unit is more than 1/8 inch out of level, shim to bring it into line.

E. Mounting Aluminum Access Hatches to Concrete:
   1. Ensure underlying concrete has cured sufficiently.
   2. Use flexible gasket material between the mounting flange and concrete.
   3. Install Type 2 joint sealant around the edges of the flange after fastening.

F. Roof Hatch Installations:
   1. Install cant strips on all sides of the roof curb to allow for slope away from curb.
   2. Install roofing material up all sides of curb and secure under counterflashing.

G. For traffic rated aluminum door styles, install structural support below the door beams as required by the Manufacturer.

3.2 QUALITY CONTROL

A. The hatch cover shall open freely along the arc between opening and closing.

B. The hatch shall be operable using one hand.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for overhead coiling doors.

1.2 REFERENCES
- A. American Society of Civil Engineers (ASCE):
  1. 7 – Minimum Design Loads for Buildings and Other Structures
- B. ASTM International (ASTM):
  1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  2. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  3. C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C. International Code Council, Inc. (ICC):
  1. 2018 International Energy Conservation Code (IECC)
- D. National Electrical Manufacturers Association (NEMA):
  1. ICS 6 – Industrial Control and Systems: Enclosures

1.3 SUBMITTALS
- A. Product Data: Information on component materials, slat profiles, finishes, operating characteristics, electric operators, accessories, and hardware.
- B. Shop Drawings: Plans, elevations, sections, and details indicating opening dimensions, guide details, head and jamb conditions, required clearances, components, and attachment. For motor operated doors provide diagrams for power and control wiring.
- C. Samples:
  1. Initial selection: Finish charts showing the full range of factory-applied finish colors.
  2. Final selections: The Manufacturer's standard size samples of selected color.
- D. Closeout Submittal: O&M data.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Performance Requirements:
  1. Structural: Design exterior doors to withstand positive and negative design wind loads as shown on the Drawings and in accordance with ASCE 7 without permanent deformation or damage.
  2. Operation cycles: Not less than 20,000.
  3. Air infiltration: Assembly in accordance with ICC 2018 IECC, C402.5.2. Air leakage less than 1.00 cfm/sf as tested by an independent testing agency.
  4. Thermal performance: Installed assembly with a tested U-factor of not more than 0.91 Btu/hr-ft2-°F, validated by an independent testing agency.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Cornell Iron Works, Inc.
- B. Overhead Door Corporation
- C. Raynor
- D. The Cookson Company, Inc.
- E. Wayne-Dalton Corporation

2.2 OPERATION
- A. Electric Operator:
  1. Type: A totally enclosed gear head operator with high starting torque and an industrial type motor with overload protection.
  2. Usage classification: 30 cycles/hr.
  3. Rating: 1/2 hp or as recommended by the Door Manufacturer for the size and type of door.
  4. Electrical characteristics: 460 VAC, three-phase.
  5. Speed reduction: Heavy duty gears running in a grease or oil bath with mechanical braking to hold the door in any position.
  6. An operator capable of driving the door at a minimum speed of 8 inches per second.
  7. Limit switch: Fully adjustable, driven linear screw type cam to synchronize the operator with the door.
  8. Provide an emergency manual chain hoist assembly that safely cuts the operator power when engaged.
  9. Control station: Three button station marked open, close, and stop. Surface-mounted, heavy duty type, with NEMA ICS 6, Type 1 enclosure.
- B. Entrapment Protection – Door Bottom Safety Edge: Full door width weather edge seal, electric sensing type, to reverse the door travel to the fully open position upon striking an object.

2.3 COMPONENTS

A. Curtain: Coiling door curtain of interlocking steel slats in a continuous length for the door width.
   1. Exterior slat material: Cold-rolled structural steel sheet with hot-dipped galvanized (G90) zinc coating in accordance with ASTM A 653, 20 gauge.
   2. Slat type: Flat insulated.
   3. Interior slat: Material: Same as exterior slat, 22 gauge minimum.
   4. Core: Foamed-in-place polyurethane insulation, with minimum R-value of 7.7 in accordance with ASTM C 177.
   5. Slat ends: Equip with end locks to act as a wearing surface and prevent lateral movement.
   6. Bottom bar: Two structural steel angles, 1 1/2 inch by 1 1/2 inch by 1/8 inch, fabricated from hot-dipped galvanized steel to match the door.

B. Guides:
   1. Three structural steel angles of a minimum 3 inch by 2 inch by 3/16 inch thickness, with zinc coating in accordance with ASTM A 123, hot-dip galvanized after fabrication.
   2. Provide windlocks of the same material as the guides when required for design wind load.

C. Counterbalance Shaft Assembly:
   1. Barrel: hot-formed, structural quality, carbon steel pipe capable of supporting the curtain load with a maximum deflection of 0.03 inch per foot of width.
   2. Spring balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of the door; provide a wheel for applying and adjusting spring torque.

D. Brackets: Fabricate from 3/16-inch steel plate, to support the counterbalance shaft assembly and the form end closures.
   1. Finish: Zinc coating in accordance with ASTM A 123 hot-dip galvanized after fabrication.

E. Hood: 24 gauge sheet steel with hot-dipped galvanized (G90) zinc coating in accordance with ASTM A 653, with reinforced top and bottom edges; provide 1/4-inch steel intermediate support brackets, at a minimum, as required to prevent excessive sag.
   1. Finish: Match slat finish.

F. Weather Seals:
   1. Door head: 1/8 inch thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
   2. Door jambs: Replaceable, adjustable, continuous, flexible, 1/8 inch thick seals of flexible vinyl, rubber, or neoprene.

G. Lock: Key cylinder type, operable from coil and fascia on both sides of the bottom bar; provide interlock switches on motor operated units.

2.4 FINISHES

A. Door Curtain Finish.
   1. Powder-coat finish: The Manufacturer’s standard powder coat finish consisting of prime coat and thermosetting topcoat. Comply with the Coating Manufacturer’s written instructions for cleaning, pretreatment, application, and minimum DFT.
   2. Color: To be selected from the Manufacturer’s full color range.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the door assembly in accordance with the Manufacturer's instructions.
B. Anchor to adjacent construction without distortion or stress.
C. Fit and align the door assembly including hardware, level and plumb, to provide smooth operation.
D. Make connections between the power supply, the operator, and the controls.
E. Make connections between the door release mechanism and the fire alarm and detection system.

3.2 ADJUSTING

A. Adjust doors for smooth operation throughout the full operating range.

END OF SECTION

SECTION 08 36 13
SECTIONAL OVERHEAD DOORS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for sectional overhead doors.

1.2 REFERENCES
- A. American Society of Civil Engineers (ASCE):
  1. 7 – Minimum Design Loads for Buildings and Other Structures
- B. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. A 924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  3. C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
  4. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- C. International Code Council (ICC):
  1. 2018 International Energy Conservation Code (IECC)

1.3 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Design Requirements:
  1. Windload: Positive and negative design wind loads as shown on the Drawings, in accordance with ASCE 7 without permanent deformation or damage.
  2. Thermal performance: Installed assembly with a tested U-factor of not more than 0.20 Btu/hr-ft2-°F, validated by an independent test agency
  3. Air infiltration: Assembly in accordance with ICC 2018 IECC, C402.5.2. Air leakage not more than 0.12 cfm/ft^2 at 25 mph, tested in accordance with ASTM E 283.

1.4 SUBMITTALS
- A. Product Data: Information on component materials, panel profiles, finishes, operating characteristics, door operators, accessories, and hardware.
- B. Shop Drawings: Plans, elevations, sections, and details indicating opening dimensions, track details, head and jamb conditions, required clearances, hardware locations, motor operator, and installation details.
- C. Samples:
  1. Initial selection: Finish charts showing the full range of factory applied finish colors.
  2. Final selection: The Manufacturer's standard size samples of selected color.
- D. Closeout Submittals: O&M data.
- E. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.5 WARRANTY
- A. Manufacturer:
  1. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the sectional overhead door system and associated appurtenances.
  2. Warranty for 10 years from the Substantial Completion date against delamination of the expanded polystyrene insulation and its exterior and interior skins, and for defects in material, workmanship, or deterioration due to rust-through.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Wayne-Dalton Corporation, Thermospan Model 200-20

2.2 MATERIALS
- A. Galvanized Steel Sheet: In accordance with ASTM A 653, Grade 40.

2.3 OPERATION
- A. Type: Motor operation.
- B. Electric Operator:
  1. Type: Jackshaft type v-belt drive with a totally enclosed motor, with an instant reversing feature.
  2. Rating: Continuous duty 3/4 hp or as recommended by the Door Manufacturer for the size and type of door.
  3. Electrical characteristics: 230/460 VAC three-phase.
  4. Control station: Three button momentary pushbutton station marked open, close, and stop.
  5. Duty cycle: 10 cycles/hr.
- C. Entrapment Protection – Door Bottom Safety Edge: Full door width, weather edge seal, electric sensing type, to reverse the door travel to the fully open position upon the striking of an object.

2.4 COMPONENTS

A. Door Sections:
   1. Construction: Exterior and interior steel skins separated by a continuous dual durometer vinyl extrusion held in place by a mechanical interlock to form an effective thermal break and a complete weathertight seal along the section joint.
   2. Exterior skin: 20 gauge roll formed, commercial quality hot-dipped galvanized steel, in accordance with ASTM A 924 and ASTM A 653.
   3. Interior skin: 26 gauge roll formed, commercial quality hot-dipped galvanized steel, in accordance with ASTM A 924 and ASTM A 653.
   4. Section thickness: 2 inches.
   5. End stiles: 16 gauge channel galvanized steel, full height, separated from the exterior skin with a vinyl thermal break.

B. Insulation: expanded polystyrene with an R-value of not less than 17.5, tested in accordance with ASTM C 177.

C. Reinforcing: Steel struts as required for the design wind load and to limit door deflection in the horizontal position to a maximum of 1/120 of the door width.

D. Track:
   1. Material: 3 inch galvanized steel, in accordance with ASTM A 653.
   2. Vertical track: Continuous angle-mounted tracks for steel or concrete jambs, graduated to provide wedge type weathertight closing, and fully adjustable for sealing the door to the jamb.
   3. Horizontal track: Reinforce with a continuous angle consistent with door size and weight.
   4. Lift type:
      a. Vertical lift track configuration: Provide where headroom is available.
      b. Lift clearance configuration: Provide where vertical lift configuration is not possible.

E. Counterbalance: Heavy duty, oil-tempered wire torsion springs on a continuous ball bearing cross header steel shaft:
   1. Provide a minimum of 100,000 cycles of use.
   2. Galvanized aircraft type lifting cables with a minimum safety factor of 5 to 1.

F. Hardware:
   1. Hinges and brackets: Form from hot-dipped galvanized steel.
   2. Track rollers: Full floating ball bearing type with hardened steel races.

G. Windows, locations as shown on the door elevation Drawings:
   1. Lights: Full view aluminum stile and rail construction color matched to door exterior finish and color.
   2. Glazing: 1/2 inch thickness insulated, clear color.
      a. Light to consist of two panes of 1/8-inch glass.
      b. Provide low E film for glass energy performance.

H. Weatherstripping: Manufacturer's full perimeter seals to comply with specified air leakage rating.
   1. Door head: A continuous length EPDM rubber sealing strip.
   2. Jambs: A clip-on rigid retainer and replaceable rubber or vinyl seal.
   3. Bottom: A continuous length aluminum retainer and a U-shaped vinyl seal.
   4. Between sections: A dual-durometer vinyl weather seal, mechanically interlocked thermal break.

I. Lock: Key cylinder type, provide interlock switches on motor operator units.

2.5 FINISHES

A. Factory-applied, two-coat, baked enamel over primer on both sides of the doors.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install the door assembly in accordance with the Manufacturer's instructions.

B. Anchor to adjacent construction without distortion or stress.

C. Fit and align the door assembly including the hardware, make level and plumb to provide smooth operation.

D. Make connections between power supply, operator, and controls.

3.2 ADJUSTING

A. Adjust doors for smooth operation throughout the full operating range.

END OF SECTION

SECTION 08 38 00
AIRCRAFT-RATED VAULT HATCHES FOR
WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for aircraft-rated vault hatches for water distribution system.

B. Related Sections:

1. SECTION 09 97 14 – COATING FOR VAULT HATCHES FOR WATER DISTRIBUTION SYSTEM

1.2 COORDINATION

A. Coordinate roof hatch installation with vault construction. Verify the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

1.3 SUBMITTALS

A. Product Data: Submit Manufacturer's product data showing general details and data, roughing-in diagrams, and installation instructions. Include operating instructions and maintenance information.

B. Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details. Show the support needed to tie into adjacent structure.

C. Warranty Documentation:

1. Sample warranty.
2. Warranty.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered in the Manufacturer's original packaging.

B. Store materials in a dry, protected, and well-vented area. Thoroughly inspect product upon receipt and report damaged material immediately to the delivering carrier and note such damage on the carrier's freight bill of lading.

C. Remove protective wrapping immediately after installation.

1.5 WARRANTY

A. Warranty for 5 years from the Substantial Completion date for the satisfactory performance and installation of the aircraft-rated vault hatches for water distribution systems and associated appurtenances. If a part fails to function in normal use within this 5-year period, the Manufacturer shall furnish a new part at no charge.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Vault Access Hatches:

1. Cavotec Dabico, DAB-38WP
2. East Jordan Iron Works, 8190 Series
3. Neenah Foundry Company, R-3498-R2S

2.2 COMPONENTS

A. Vault Access Hatch:

1. Cover: DI, torsion-actuated, rated for aircraft wheel loads. Waterproof elastomeric door seal if available. Design for casting into the concrete of the vault roof.
2. Latch: Latch handle with no above-grade protrusions. Dual latches, activated by operating only one latch.
3. Operation: Open to 90-degree position with maximum 25 lb pull; close with minimum 50 lb push.
4. Hold-open bar: Automatically lock in full-open position. Release with one-hand operation.
5. Ladder extension: 42-inches high, telescoping steel tube, automatically locking when extended.
6. Identification: Service lettering shall be 2 inches high and 1/16 inch deep and shall consist of the word WATER in capital letters.

2.3 FINISHES

A. Field coating: Paint as specified in SECTION 09 97 14.

PART 3 EXECUTION

3.1 INSTALLATION

A. Check As-Built conditions and verify the Manufacturer's hatch details for accuracy to fit the application prior to fabrication. Comply with the Manufacturer's installation instructions.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 41 13
ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for aluminum entrances and storefronts.

B. Related Sections:

1. SECTION 07 92 00 – JOINT SEALANTS
2. SECTION 08 44 13 – ALUMINUM CURTAIN WALLS
3. SECTION 08 51 13 – ALUMINUM WINDOWS
4. SECTION 08 71 00 – DOOR HARDWARE
5. SECTION 08 80 00 – GLAZING

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. 701/702 – Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals
2. 1503 – Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

B. Americans with Disabilities Act (ADA):

1. ADA-Architectural Barriers Act (ABA) Accessibility Guidelines

C. ASTM International (ASTM):

1. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
2. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. B 308 – Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
4. D 2000 – Standard Classification System for Rubber Products in Automotive Applications
5. D 2287 – Standard Classification System and Basis for Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
6. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
7. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
8. E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

D. National Fenestration Rating Council (NFRC):

1. 100 – Procedure for Determining Fenestration Product U-Factors

1.3 SUBMITTALS

A. Product Data:

1. Construction information and fabrication methods.
2. Data on hardware, accessories, and finishes.
3. Recommendations for the maintenance and cleaning of exterior surfaces.

B. Shop Drawings:

1. Location and layout.
2. Elevations of each type of storefront or entrance system at 1/4 scale minimum.
3. Details including anchorage.
4. Sections, 1/2 scale minimum, of each storefront or entrance system installation condition showing:
   a. Components, accessories, and reinforcement.
   b. Adjacent substrate, finishes, and the location of the window within the opening.

C. Samples:

1. Finish samples in the specified color: 3 inches by 3 inches.

D. Quality Control Submittals: Product test reports from AAMA accredited laboratories indicating compliance with the specified performance requirements.

E. Warranty Documentation:

1. Sample warranty.
2. Warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of 10 years of documented experience in the Work of this Section and regularly engaged in the design and fabrication of framing systems of similar scope and type similar to those of this Project.

1. A Manufacturer capable of fabricating entrance and storefront systems that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
2. Engineering responsibility: Provide entrance and storefront systems based on testing and engineering analysis of the Manufacturer's standard units in assemblies similar to those shown on the Drawings for this Project.

B. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.
2. Manufacturer's Representative who is trained and approved for installation of units required for the project.

C. Accessible Entrances: Comply with applicable provisions in the ADA-ABA Accessibility Guidelines and ANSI A 117.1.

D. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified Professional Engineer, using performance requirements and design criteria indicated.
E. Structural Loads:
   1. Wind loads: As shown on the Drawings.
F. Performance Requirements:
   1. System Description:
      a. Aluminum-framed storefront system includes tubular aluminum sections with supplementary internal support framing as required, aluminum and glass entrances, and shop-fabricated, factory-finished, glass and glazing, related flashings, anchorage, and attachment devices.
      b. System assembly: Site assembled.
   2. Fixed framing and glazing performance requirements:
      a. Thermal transmittance: Average maximum U-value of 0.36 Btu/hr-ft2-°F, when glazed with 0.29 center of glass U-factor, tested in accordance with NFRC 100.
      b. Condensation resistance test: Minimum CRF of 51, tested in accordance with AAMA 1503.
      c. Air infiltration: Maximum 0.06 cfm/sf, tested in accordance with ASTM E 283 at static air pressure difference of 6.24 psf.
      d. Water resistance: No water penetration, tested in accordance with ASTM E 331 at a static air pressure difference of 20% of positive wind-load design pressure, but not less than 10 lbf/sf.
      e. Uniform load deflection test:
         1) Test in accordance with ASTM E 330.
         2) Deflection under design load shall not exceed L/175 of the clear span.
      f. Uniform load structural test:
         1) Test in accordance with ASTM E 330 at a pressure 1.5 times the design positive and negative wind pressure.
         2) No evidence of material failure, structural distress, glass breakage, or permanent damage or deformation to framing, fasteners, and hardware parts.
      g. Movement caused by an ambient temperature range of 120°F and a surface temperature range of 180°F.
   3. Entrance door system performance requirements:
      a. Air leakage: Tested in accordance with ASTM E 283, at a static air pressure differential of 1.57 psf, based on door leaf module of 35.43 inches by 82.68 inches.
         1) Single door and frame: Maximum 0.50 cfm/sf of unit.
         2) Pair of doors and frame: Maximum 0.10 cfm/sf of unit.
      b. Uniform load structural test:
         1) Tested in accordance with ASTM E 330 at a static air pressure difference of 60 psf, both positive and negative air pressure.
         2) At the conclusion of the test there shall be no glass breakage, permanent damage to fasteners, hardware parts, or actuating mechanisms, nor any damage causing the door to be inoperable.
      c. Thermal transmittance: U-value of 0.36 Btu/hr-ft2-°F, when glazed with 0.29 center of glass U-factor, tested in accordance with NFRC 100.
G. Provide aluminum products from the same Manufacturer of products as specified in SECTION 08 44 13 and SECTION 08 51 13.

1.5 WARRANTY
A. Manufacturer:
   1. Warranty for 3 years from the Substantial Completion date for the satisfactory performance and installation of the aluminum entrance and storefront system and associated appurtenances.
   2. Repair or replace components of entrance and storefront systems that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Failure of the system to meet performance requirements.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Failure of operating components to function normally.
      e. Water leakage through fixed glazing and frame areas.
   3. Glazing: Provide a warranty for insulated units as specified in SECTION 08 80 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Aluminum Entrances and Storefronts:
   1. EFCO Corporation. XTherm Series 403X with Thermastile D502 Entrance
   2. Kawneer North America; an Alcoa company; TRIFAB 451 UT with 560 Insulclad Entrance
   3. United States Aluminum Series 45X with Series 750T Entrance
B. Continuous, Gear-Type Hinges:
   1. ABH Manufacturing Inc.
   2. Bommer Industries, Inc.
   3. Hager Companies
   4. IVES Hardware; an Ingersoll-Rand company
   5. McKinney Products Company; an ASSA ABLOY Group company

6. Select Products Limited
7. Stanley Commercial Hardware; Div. of The Stanley Works
8. Zero International

2.2 MATERIALS

A. General:
1. Aluminum extruded bars, rods, profiles, and tubes: In accordance with ASTM B 221.
2. Aluminum plate: In accordance with ASTM B 209.
3. Structural profiles: In accordance with ASTM B 308.
4. Provide aluminum products from the same Manufacturer of products as specified in SECTION 08 51 13.

B. Storefront Framing: The Manufacturer's standard extruded-aluminum framing members.
1. Frame nominal wall thickness: 0.080 inch.
2. Frame member depth: 4 1/2 inches.
3. Frame member face: 2 inches.
4. Thermal barrier: Rigid, structural thermal barrier providing a separation between interior and exterior aluminum surfaces consisting of two-part, poured-in-place, high-density polyurethane.
5. Glazing system: Retained mechanically with gaskets on four sides.
6. Glazing plane: Center.

C. Entrance Doors:
1. Type: Stile and rail design of 2 inch tubular framing members. Exterior corner construction is true mortise and tenon for physical interlock between the rails and stiles. Interior corner construction shall be joined by heavy concealed reinforcement brackets with screws and shall be of deep penetration and fillet welded.
2. Frame nominal wall thickness: 0.125 inch.
3. Door moldings nominal wall thickness: 0.050 inch.
4. Stile width: 5 inches.
5. Top rail height: 5 inches.
6. Mid-rail height: 5 inches.
7. Bottom rail height: 7 1/2 inches, one-piece seamless construction.
8. Thermal barrier: Rigid, structural thermal barrier. The thermal barrier shall be thermal struts, consisting of glass reinforced polyamide nylon, mechanically crimped in raceways extruded in the exterior and interior extrusions.

D. Entrance Weatherstripping:
1. Compression type: In accordance with ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC, as suitable for the type of door operation.
2. Sliding type: AAMA 701/702, made of wool, PP, or nylon woven pile with nylon-fabric or aluminum-strip backing.

E. Flashing: Provide closures and flashing, the size and thickness shown on the Drawings, of aluminum sheet in accordance with ASTM B 209 and finish matching framing members.

F. Brackets and reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

G. Framing System Gaskets, Sealants, and Joint Fillers: Type as recommended by the Manufacturer for the joint condition.

H. Glass and Glazing Accessories: As specified in SECTION 08 80 00.

I. Glazing Gaskets: The Manufacturer's standard compression types; replaceable, molded or extruded, of the profile and hardness required to maintain a watertight seal.

J. Perimeter Joint Fillers and Sealants: As specified in SECTION 07 92 00.

K. Fasteners: Provide fasteners of aluminum, non-magnetic SST, or other materials warranted by the Manufacturer to be non-corrosive and compatible with system components.
1. Reinforcement: Add fasteners to aluminum less than 0.125 inch thick, reinforce the interior with aluminum or non-magnetic SST to receive screw threads or provide standard noncorrosive pressed in splined grommet nuts.
2. Exposed fasteners: Use only where unavoidable for application of hardware; match the finish of the member or hardware being fastened. Where used, provide exposed fasteners with countersunk Phillips screw heads.

2.3 ACCESSORIES

A. Entrance Door Hardware:
1. Continuous, gear-type hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
a. Product system basis: ABH Manufacturing Inc. A111HD.
b. Fasteners: Sizes 12-24 by 7/8 inch undercut self-drilling thread-forming tek machine screws.
c. Finish: Match door finish.
d. Reinforce tubular aluminum sections with an aluminum back-up strap.
2. Refer to the hardware schedule as specified in SECTION 08 71 00 for items noted below that are not provided by the Entrance System Manufacturer:
a. Surface-mounted door closers.
b. Cylinders.
c. Panic.
d. Pull handles.
e. Threshold.
f. Weatherstrip: The Door Manufacturer’s standard at head and jambs; as specified in the hardware schedule in SECTION 08 71 00.
g. Sill sweep.

2.4 FABRICATION

A. Fabricate framing in the profiles as shown on the Drawings for flush glazing, without projecting stops.
B. Fabricate door framing in the profiles as shown on the Drawings.
C. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.
D. Weld or mechanically fasten components along the entire line of contact on the unexposed side.
E. Fabricate in the largest practicable units.
F. Reinforce members and joints with plates, bars, or angles for rigidity and strength as needed to fulfill the performance requirements.
G. Fabricate aluminum components with an integral low conductance thermal barrier located between the exterior and the interior exposed components that eliminates metal-to-metal contact.
H. Conceal fasteners and attachments from view.
I. Fabricate components to drain water passing joints and moisture occurring or migrating within the system to the exterior.
J. Form glass stops, exterior sills, closures, weatherstops, and flashings of the same material as the frame.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install entrance and storefront components in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Set plumb, level, rigid, and free from warp or rack.
C. Anchor to supporting construction.
D. Install members with adequate provision for settling, expanding, and contracting to occur without breaking glass.
E. Set continuous sill members and flashing in a full sealant bed.
F. Separate aluminum from contact with dissimilar metals and concrete by applying sealant, tape, or bituminous paint recommended by Manufacturer for this purpose.
G. Provide gasket assemblies that have the corners sealed with sealant recommended by the Gasket Manufacturer.
H. Install components to drain water passing joints and moisture occurring or migrating within the system to the exterior.
I. Installation Tolerances:
    1. Maximum variation from plumb or level: 1/8 inch in 12 feet or 1/4 inch over total length.
    2. Maximum misalignment of members abutting end to end: 1/32 inch.
J. Install glazing as specified in SECTION 08 80 00.
K. Seal joints between framing and substrate to provide a weathertight installation at opening perimeters as specified in SECTION 07 92 00.

3.2 ADJUSTING

A. Adjust for entrances for smooth operation.
B. Touch up minor scratches and abrasions to match original finish.

END OF SECTION

SECTION 08 44 13
ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for aluminum curtain walls.

B. Related Sections:

1. SECTION 07 92 00 – JOINT SEALANTS
2. SECTION 08 41 13 – ALUMINUM ENTRANCES AND STOREFRONTS
3. SECTION 08 51 13 – ALUMINUM WINDOWS
4. SECTION 08 80 00 – GLAZING

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. 501.1 – Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
2. 1503 – Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections

B. ASTM International (ASTM:

1. A 36 – Standard Specification for Carbon Structural Steel
2. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
3. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
4. B 308 – Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
5. E 90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
6. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
7. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
8. E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

C. National Fenestration Rating Council (NFRC):

1. 100 – Procedure for Determining Fenestration Product U-Factors

1.3 SUBMITTALS

A. Product Data: Provide for each product required, including:

1. Construction information and fabrication methods.
2. Data on hardware, accessories, and finishes.
3. Recommendations for the maintenance and cleaning of exposed surfaces.

B. Shop Drawings:

1. Location and layout.
2. Elevations of each type of aluminum curtain wall at 1/4 scale, at a minimum.
3. Details including anchorage.
4. Sections, 1/2 scale minimum, of each aluminum curtain wall system installation condition showing:
   a. Accessories and reinforcement.
   b. Adjacent substrate, finishes, and the location of the window within the opening.

C. Samples:

1. System corner: Minimum of 6 inches by 6 inches showing corner construction, cross-section, and finish.
2. Finish samples in the specified color: 3 inches by 3 inches.

D. Quality Control Submittal: Product test reports from AAMA accredited laboratories indicating compliance with the specified performance requirements.

E. Warranty Documentation:

1. Sample warranty.
2. Warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of 10 years of documented experience in the Work of this Section; regularly engaged in the design and fabrication of framing systems of the scope and type similar to this Project.

1. A Manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
2. Engineering responsibility: Provide aluminum curtain wall systems based on testing and engineering analysis of the Manufacturer’s standard units in assemblies similar to those shown on the Drawings for this Project.
3. If the Work required in this Section includes the installation of steel angle supports connecting the curtain wall system to the building structure, include the engineering analysis and provisions for building movements.

B. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.
2. Manufacturer's Representative who is trained and approved for installation of units required for the project.

C. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified Professional Engineer, using performance requirements and design criteria indicated.

D. Structural Loads:

1. Wind loads: As shown on the Drawings.

E. Performance Requirements:
1. Fixed framing and glazing performance requirements:
a. Thermal transmittance: U-factor of not more than 0.37 Btu/hr-ft2-°F when glazed with 0.29 center of glass U-factor, as determined in accordance with NFRC 100.
b. Condensation resistance test: Minimum CRF of 74, tested in accordance with AAMA 1503.
c. Air infiltration: Maximum 0.06 cfm/sf, tested in accordance with ASTM E 283 at a static air pressure difference of 6.24 psf.
d. Water resistance: No water penetration as defined by AAMA 501.1, paragraph 5.5, through fixed glazing and framing areas when tested in accordance with ASTM E 331 at a minimum static-air-pressure differential of 15 lbf/sf.
e. Uniform load deflection test:
1) Test in accordance with ASTM E 330.
2) Deflection normal to wall plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
f. Uniform load structural test:
1) Test in accordance with ASTM E 330 at a pressure 1.5 times the design positive and negative wind pressure.
2) No evidence of material failure, structural distress, glass breakage, or permanent damage or deformation to framing, fasteners, and hardware parts.
g. Dead loads: Provide system members that do not deflect an amount that reduces the glazing bite below 75% of the design dimension when carrying a full dead load.
h. Reglazing: Vision and spandrel units are to be reglazable from the exterior.
i. Sound transmission: STC rating of 29, tested in accordance with ASTM E 90.
j. Movement caused by an ambient temperature range of 120°F and a surface temperature range of 180°F.

F. Provide aluminum products from the same Manufacturer of products as specified in SECTION 08 41 13 and SECTION 08 51 13.

1.5 WARRANTY

A. Manufacturer:
1. Warranty for 3 years from the Substantial Completion date for the satisfactory performance and installation of the aluminum curtain wall system and associated appurtenances.
2. Repair or replace components of entrance and storefront systems that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to:
a. Structural failures including, but not limited to, excessive deflection.
b. The failure of the system to meet performance requirements.
c. The deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. The failure of operating components to function normally.
e. Adhesive or cohesive sealant failures.
f. Water leakage through fixed glazing and frame areas.
3. Glazing: Provide a warranty for insulated units as specified in SECTION 08 80 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. EFCO Corporation, Series 5600 Outside Glazed with Duracast Fiberglass Pressure Plate
B. Kawneer North America; an Alcoa company, 1600UT System 1
C. Oldcastle Building Envelope, Reliance Curtainwall

2.2 MATERIALS

A. General:
1. Aluminum extruded bars, rods, profiles, and tubes: In accordance with ASTM B 221.
2. Aluminum plate: In accordance with ASTM B 209.
3. Structural profiles: In accordance with ASTM B 308.

B. Curtain Wall Framing: The Manufacturer's standard extruded-aluminum framing members.
1. Frame nominal wall thickness: 0.093 inch to 0.125 inch.
2. Frame member depth: 6 inches.
3. Frame member face: 2 1/2 inches.
4. Thermal barrier: Thermally improved through the Manufacturer’s composite fiberglass pressure plate.
a. Pressure plate: Material shall be a fiberglass composite with a flexural strength of no less than 82 ksi along the lineal’s major axis.
b. Material thermal conductivity shall be no more than 2 BTU·in/hr·ft2·°F.
5. Glazing system: Retained mechanically with gaskets on four sides.
6. Glazing plane: Center.

C. Steel Clip Angles/Supports: Structural shapes, plates, and bars, in accordance with ASTM A 36.
D. Flashing: Provide closures and flashing of aluminum sheet of the size and thickness shown on the Drawings in accordance with ASTM B 209, and finish matching the framing members.
E. Brackets and Reinforcements: The Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
F. Framing System Gaskets, Sealants, and Joint Fillers: The type recommended by the Manufacturer for the joint condition.
G. Glass and Glazing Accessories: As specified in SECTION 08 80 00.

H. Glazing Gaskets: The Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
I. Perimeter Joint Fillers and Sealants: As specified in SECTION 07 92 00.
J. Fasteners: Provide fasteners of aluminum, non-magnetic SST, or other materials warranted by the Manufacturer to be non-corrosive and compatible with system components:
1. Reinforcement: At fasteners to aluminum less than 0.125 inch thick, reinforce the interior with aluminum or non-magnetic SST to receive screw threads, or provide standard non-corrosive pressed in splined grommet nuts.
2. Exposed fasteners: Use only where unavoidable for the application of hardware; match the finish of the member or hardware being fastened. Where used, provide exposed fasteners with countersunk Phillips screw heads.

2.3 FABRICATION
A. Fabricate framing in the profiles as shown on the Drawings.
B. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.
C. Weld or mechanically fasten components along the entire line of contact on the unexposed side.
D. Fabricate in the largest practicable units.
E. Reinforce members and joints with plates, bars, or angles for rigidity and strength as needed to fulfill performance requirements.
F. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
7. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
G. Curtain Wall Framing: Fabricate components for assembly using shear-block system.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install components in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Set plumb, level, rigid, and free from warp or rack.
C. Anchor to supporting construction.
D. Install members with an adequate provision for settling, expanding, and contracting to occur without breaking the glass.
E. Set continuous sill members and flashing in a full sealant bed.
F. Separate aluminum from contact with dissimilar metals and concrete by applying sealant, tape, or bituminous paint as recommended by the Manufacturer.
G. Install components to drain water passing joints and moisture occurring or migrating within the system to the exterior.
H. Installation Tolerances:
1. Maximum variation from plumb or level: 1/8 inch in 12 feet or 1/4 inch over the total length.
2. Maximum misalignment of members abutting end to end: 1/32 inch.
I. Install glazing as specified in SECTION 08 80 00.
J. Seal joints between the framing and the substrate to provide a weathertight installation at opening perimeters as specified in SECTION 07 92 00.

3.2 ADJUSTING
A. Touch up minor scratches and abrasions to match the original finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 45 23
FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for fiberglass-sandwich-panel assemblies.

B. Related Sections:

1. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. 501.2 – Quality Assurance and Water Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
2. 611 – Voluntary Specification for Anodized Architectural Aluminum
3. 1503 – Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections

B. American Society of Civil Engineers (ASCE):

1. 7 – Minimum Design Loads for Buildings and Other Structures

C. American Welding Society (AWS):

1. D1.2 – Structural Welding Code – Aluminum

D. ASTM International (ASTM):

1. A 36 – Standard Specification for Carbon Structural Steel
2. A 193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
3. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
4. B 85 – Standard Specification for Aluminum-Alloy Die Casting
5. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
7. C 297 – Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
8. D 395 – Standard Test Methods for Rubber Property – Compression Set
9. D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
10. D 865 – Standard Test Method for Rubber-Deterioration by Heating in Air (Test Tube Enclosure)
11. D 925 – Standard Test Methods for Rubber Property – Staining of Surface (Contact, Migration, and Diffusion)
12. D 1002 – Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
13. D 1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
14. D 1056 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber
15. D 1149 – Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment
16. D 1929 – Standard Test Method for Determining Ignition Temperature of Plastics
17. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
18. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Difference Across the Specimen
19. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
20. E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

E. National Fenestration Rating Council (NFRC):

1. 100 – Procedure for Determining Fenestration Product U-Factors
2. 200 – Determining Fenestration Product Solar Heat Gain Coefficient

F. Underwriters Laboratories (UL):

1. 972 – Standard for Burglary Resisting Glazing Material

1.3 SUBMITTALS

A. Product Data: Include material descriptions, product details, and finish data for system components.

B. Shop Drawings:

1. Joining techniques, provision for expansion and contraction, anchorage details, and framing member profiles, elevations, and details.
2. Materials and finishes.
3. The relative layout of adjacent and supporting construction.
4. Translucent panels, setting blocks, jamb blocking, and glazing seals.
5. Weep drainage network.
6. Joint sealants, backer rods, bond breakers, and primers.
7. Loads applied to structure: Location, direction, and magnitude.

C. Samples:

1. Translucent panels: 12 inches by 12 inches showing the exterior and the interior skin color and the required light transmittance.
2. Finish samples: The Manufacturer's standard size color samples of each specified material showing the full range of available colors.

D. Quality Control Submittals:
   1. Test reports: Certified results of previous tests by a recognized independent testing laboratory substantiating compliance with the specified design and performance criteria.
   2. Welder qualifications: In accordance with AWS D1.2.
E. Warranty Documentation:
   1. Sample warranty.
   2. Warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. A minimum of 10 years of documented experience in the Work of this Section.
   2. Capable of providing field service representation during installation.
B. Installer Qualifications:
   1. A minimum of 5 years of documented experience in the Work of this Section.
   2. Approved by the Manufacturer.
C. Delegated Design: Design fiberglass sandwich panel assemblies, including engineering analysis by a qualified Professional Engineer, using performance requirements and design criteria specified.
D. Welder Qualifications: In accordance with AWS D1.2.
E. Mockup:
   1. Size: 4 feet wide by 8 feet high.
   2. Include attachments, framing, translucent panels, trim, and sealers.
   3. Locate where directed.
   4. The approved mockup shall not remain as part of the Work.
F. Performance Requirements:
   1. System Description: Translucent panel system of reinforced double-faced composite sandwich panels, thermally broken, with support framing, battens, cap strips, related flashings, anchorage, and attachment devices.
   2. General performances: Fiberglass sandwich panel assemblies shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction.
      a. Structural loads.
      b. Thermal movements.
      c. Movements of supporting structure.
      d. Dimensional tolerances of the building frame and other adjacent construction.
      e. Failure includes, but is not limited to, the following:
         1) Deflection exceeding specified limits.
         2) Water leakage.
         3) Thermal stresses transferred to building structure.
         4) Noise or vibration created by wind, thermal, or structural movements.
         5) Loosening or weakening of fasteners, attachments, and other components.
   3. Structural loads:
      a. Wind loads: As shown on the Drawings.
      b. Design wind pressure in accordance with ASCE 7 and local building codes, tested in accordance with ASTM E 330. The system shall withstand the loads normal to the wall plane in accordance with the Contract Documents.
   4. Expansion and contraction: Design and install components with provisions for expansion and contraction due to a 100˚F temperature variation.
   5. Deflection and stress limits: Normal to the plane of the panels, deflection of framing members shall not exceed 1/120 of the span.
   6. Safety factors – allowable stresses shall incorporate the following safety factors unless otherwise specified:
      a. Load carrying members: 1.65.
      b. Load carrying fasteners: 2.0.
   7. Design of the system shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
   8. Uniform structural loading: No panel breakage or permanent damage to fasteners or system components, tested in accordance with ASTM E 330 at 1.5 times the positive and negative wind-load design pressure.
   9. Air infiltration: Maximum 0.01 cfm/sf, tested in accordance with ASTM E 283 at a minimum static air pressure differential across assembly of 6.24 psf.
   10. Water penetration: No water penetration in accordance with AAMA 501.2, tested in accordance with ASTM E 331 at a minimum of 15.0 psf.
   11. Thermal transmittance (U-factor):
      a. Fixed glazing and framing areas shall have a U-factor of not more than 0.29 Btu/hr-ft2-°F as determined in accordance with NFRC 100.
      b. Fiberglass panel shall have U-factor of not more than 0.23 Btu/hr-ft2-°F as determined in accordance with NFRC 100.
   12. Solar heat gain coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.31 as determined in accordance with NFRC 200.
   13. CRF: Minimum 80, tested in accordance with AAMA 1503.

1.5 WARRANTY

A. System Warranty: The Manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within the specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Water leakage.
   2. Warranty period: 1 year from the Substantial Completion date.

B. Fiberglass Sandwich Panel Warranty: The Manufacturer agrees to replace panels that exhibit defects in materials or workmanship.
   1. Defects include, but are not limited to the following:
      a. Fiberbloom.
      b. Delamination of coating, if any, from exterior face sheet.
      c. Color change exceeding requirements.
      d. Delamination of panel face sheets from panel cores.
      e. Warranty period: 10 years from the Substantial Completion date.
   2. Finish warranty: The Manufacturer agrees to repair or replace components on which finishes fail within the specified warranty period. Warranty does not include normal weatherbearing.
      a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
      b. Warranty period: 10 years from the Substantial Completion date.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Kalwall Corporation

B. Major Industries, Inc.

2.2 MATERIALS

A. Aluminum Components: Alloy and temper best suited to the application.
   1. Extrusions: In accordance with ASTM B 221.
   2. Sheet: In accordance with ASTM B 209.
   3. Castings: In accordance with ASTM B 85.

B. Steel Shapes: In accordance with ASTM A 36.

2.3 COMPONENTS

A. Panels:
   1. Description: Assembly of uniformly colored, translucent, thermoset, fiberglass reinforced polymer face sheets bonded under controlled heat and pressure, to produce a straight full width consistent bonding line, to both sides of a mechanically interlocked aluminum I-beam grid core to form double-faced self-supporting sandwich panels.
   2. Size: 2 3/4 inches deep.
   3. Nominal grid size: 12 inches by 24 inches.
   4. Grid pattern: In-line Shoji.
   5. Colors:
      a. Exterior sheet: Crystal.
      b. Interior sheet: White.
   6. Thermal resistance: U-value of no more than 0.23 Btu/hr-ft2-°F.
   7. Visible light transmittance: 25% minimum.
   8. Solar heat gain coefficient: 0.31 maximum.
   9. I-beam grid core:
      a. Material: In accordance with ASTM B 221, 6061-T6, aluminum-alloy.
      b. Flange width: 7/16 inch minimum.
      c. Web thickness: 0.050 inch.
      d. Mechanically interlocked.
      e. Full surface contact with face sheets.
      f. Thermal break:
         1) Located in the panel grid core.
         2) Poured and debridged structural polyurethane, insulating U-factor of 0.5.
   10. Panel weeps: Weep holes provided on the bottom side of wall systems of installed panels to permit condensation to leave the interior of the panel.
   11. Adhesive:
      a. Laminate adhesive: Waterproof resin for use in laminating the polyester sheet to the aluminum grid core.
      b. Impact and thermal shock: Adhesive capable of withstanding impact and thermal shock normally encountered in exterior construction.
      c. Adhesive bond line: Straight, black, and cover the entire width of the I-beam with a neat, sharp edge.
      d. Initial bond strength between face sheet and grid core:
         1) Shear strength: 563 psi in accordance with ASTM D 1002.
         2) Tensile strength: 557 psi in accordance with ASTM C 297.
      e. Aged adhesive bond strength: In accordance with ASTM D 1037: Tensile strength 900 psi minimum, in accordance with ASTM C 297, shear strength 1,200 psi in accordance with ASTM D 1002.

12. Exterior face sheet:
    a. Darkening: Color change on the exterior sheet shall not exceed 3.0 Delta E units after 5 years of South Florida (or accelerated test equivalent) weathering.
    b. Impact strength: UL 972, 70 ft-lbs impact energy.
    c. Thickness: 0.070 inch.
    d. Color: Crystal.
    e. Protective weathering surface: Self-cleaning thermoset acrylic urethane surface molecularly bonded under factory-controlled conditions, minimum thickness: 1 mil, fully field repairable.
13. Interior face sheet:
    a. Flame spread, in accordance with ASTM E 84: 25 maximum.
    b. Smoke development, in accordance with ASTM E 84: 300 maximum.
    c. Burn rates in accordance with ASTM D 635: 1 inch/minute maximum.
    d. Self-ignition, in accordance with ASTM D 1929: Greater than 650°F
    e. Thickness: 0.045 inch.
    f. Color: White.

B. Framing Materials:
1. Aluminum:
    a. Extruded aluminum: In accordance with ASTM B 221, Alloy 6063-T5/T6, 6061-T5/T6.
    b. Formed aluminum components and flashing: In accordance with ASTM B 209, Alloy 5005-H34.
    c. Minimum thickness: 0.040 inch.
2. Interior glazing gaskets:
    a. Extruded closed-cell sponge neoprene hybrid, 9/16 inch wide.
    b. Factory-installed in extruded dovetail slots.
    c. Compression deflection, 25% deflection limits, in accordance with ASTM D 1056, 13 psi to 24 psi.
    d. Compression set, 22 hours at 158°F, maximum percent, in accordance with ASTM D 395, Method B: 30 psi.
    e. Heat aging, 70 hours at 212°F, change in compression values, in accordance with ASTM D 865 and ASTM D 1056: 0 psi to 10 psi.
    f. Ozone resistance at 40% elongation, 100 hours at 104°F, in accordance with ASTM D 1149:
        1) Type I, 1 ppm ozone: No cracks.
        2) Type II, 3 ppm ozone: No cracks.
    g. Staining of surface, in accordance with ASTM D 925: Nonstaining, no migratory stain.

C. Condensation Control System:
1. Mechanically design the entire system to function properly with minimal dependency upon the sealants.
2. Weep holes/integral gutter system: Located as required to control condensation that may enter system by allowing it to pass to the exterior.

D. Glazing Caps:
1. Extruded aluminum.
2. Attach with glazing cap fasteners located at a maximum of 12 inches on center or as required to resist negative loading.

2.4 ACCESSORIES

A. Fasteners: The Manufacturer's standard corrosion-resistant, non-staining type recommended for application.
1. ASTM A 193, series 300 SST for wet locations and exposed fasteners.
2. Stainless or corrosion-resistant coated steel for other locations.
3. Exposed fasteners: The finish shall match the aluminum.

B. Joint Sealants: As specified in SECTION 07 92 00 for the perimeter.
C. Anchor Bolts: In accordance with ASTM A 307, Grade A galvanized steel.
D. Exposed Flashing and Closures: Aluminum sheet not less than 0.050 inch thick, finished to match the framing.
E. Primer Paint: Zinc-rich type.

2.5 FABRICATION

A. Fabricate with minimum clearances and shim spaces around the perimeter while enabling installation and dynamic movement.
B. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.
C. Fabricate in the largest practicable units.
D. Conceal fasteners and attachments from view.
E. Reinforce framing members with internal steel when required to support imposed loads.
F. Fabricate so that components will not be excessively strained under the normal conditions of use.
G. Provide slotted holes for erection adjustment.
H. Provide fascias, covers, closures, and trim members that are attached to the translucent panel system.
I. Make provisions in the design to drain to the exterior any leakage of water occurring at joints and condensation taking place within construction. Provide gutters at horizontals at the bottom of panels; weep to exterior through baffled weep holes.
J. Fabricate aluminum components with an integral low conductance thermal barrier located between the exterior and the interior exposed components that eliminates metal-to-metal contact.

2.6 FINISHES

A. Aluminum: Anodized to 0.0007 inch minimum thickness, bronze color, in accordance with AAMA 611 (AA-M10-C22-A42) Architectural Class I.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Install components plumb and level, in the proper plane, free from warp and twist.
C. Anchor to supporting construction.
D. Weld adjustable anchorage connections after the translucent panel system is properly positioned. Perform welding in accordance with AWS D1.2.
E. Compensate for predictable conditions that could cause the system to exceed the allowable tolerances.
F. Accommodate thermal and mechanical movements.
G. Employ reinforcing members if required. If temporary braces or erection clips are used, prevent damage to exposed surfaces.
H. Install components including flashings, fasteners, hardware, sealants, and glazing materials required for a complete, weatherproof installation.
I. Install framing components to drain water-passing joints and to drain condensation and moisture occurring or migrating within the skylight system to the exterior.
J. Installation Tolerances:
    1. Variation from plane or locations shown on the Shop Drawings: Maximum 1/8 inch in 10 feet of length or 1/2 inch in any total length.
    2. Offset from true alignment between two identical members abutting end to end in line: Maximum 1/32 inch.
    3. Joint sealant space between translucent panel system and adjacent construction: 1/4 inch, ±1/8 inch.

3.2 CLEANING

A. Clean panels and components inside and outside, immediately after installation, and after sealants have cured, in accordance with the Manufacturer's recommendations.
B. Remove temporary protective coverings and strippable coatings from prefinished metal surfaces. Remove labels and markings from components.

3.3 ADJUSTING

A. Touch up minor scratches and abrasions on finished surfaces to match the original finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for aluminum windows.

B. Related Sections:

1. SECTION 07 92 00 – JOINT SEALANTS
2. SECTION 08 80 00 – GLAZING

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. 910 – Voluntary "Life Cycle" Specifications and Test Methods for AW Class Architectural Windows and Doors
2. 1503 – Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections

B. American Architectural Manufacturers Association/Window and Doors Manufacturers Association/CSA Group (AAMA/WDMA/CSA):

1. 101/I.S. 2/A440 – Specification for Windows, Doors, and Skylights

C. American National Standards Institute/Builders Hardware Manufacturers Associations (ANSI/BHMA):

1. A156.18 – Materials and Finishes

D. American Society of Civil Engineers (ASCE):

1. 7 – Minimum Design Loads for Buildings and Other Structures

E. ASTM International (ASTM):

1. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
2. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
3. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
4. E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
5. F 588 – Standard Test Methods for Measuring the Force Entry Resistance of Window Assemblies, Excluding Glazing Impact

1.3 SUBMITTALS

A. Product Data:

1. Construction information and fabrication methods.
2. Data on hardware, accessories, and finishes.
3. Recommendations for the maintenance and cleaning of exposed surfaces.

B. Shop Drawings:

1. Location and layout.
2. Elevations of each type of window at 1/4 scale, minimum.
3. Details including anchorage.
4. Sections, 1/2 scale minimum, of each window installation condition showing:
   a. Window section with accessories and reinforcement.
   b. Adjacent substrate, finishes, and the location of the window within the opening.

C. Samples:

1. Window corner, minimum 6 inch by 6 inch, showing corner construction, cross-section, and finish.
2. Finish samples in the specified color: 3 inches by 3 inches.

D. Warranty Documentation:

1. Sample warranty.
2. Warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. A minimum of 5 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.

B. Test Reports: Provide test reports from AAMA accredited laboratories with the Window Manufacturer's letter of certification stating that the tested window meets or exceeds the referenced performance criteria.

C. Conform to the applicable accessibility code for locating hardware.

D. Performance Requirements:

1. Window design and performance: In accordance with AAMA/WDMA/CSA 101/I.S. 2/A440.
   a. Product type:
      1) Compression seal windows: AP – projected.
      2) Fixed windows: F – Fixed.
   b. Life cycle testing: In accordance with AAMA 910.
   c. Thermal transmittance of window assembly: Tested in accordance with NFRC 100 with 1 inch insulated glazing with a center of glass U-value of 0.29 Btu/sf/hr/ºF:
      1) Fixed units: Maximum U-value of 0.38 Btu/hr-ft2-°F.
      2) Projected out units: Maximum U-value of 0.47 Btu/hr-ft2-°F.

d. CRF: Tested in accordance with AAMA 1503 with 1 inch insulated glazing with a center of glass U-value of 0.28 Btu/sf/hr/ºF.
1) Fixed units: Minimum 69.
2) Projected out units: Minimum 66.
e. Forced entrance resistance: In accordance with ASTM F 588; meet the requirements of performance grade 40.
f. Air infiltration: Maximum 0.1 cfm/sf, tested in accordance with ASTM E 283 at a static air pressure difference of 6.27 psf.
g. Water resistance: No uncontrolled water leakage allowed, tested in accordance with ASTM E 331 at a static air pressure difference of 15 psf.
h. Uniform load structural test: No glass breakage or damage to window parts, tested in accordance with ASTM E 330 at a minimum static air pressure difference of 135 psf.
2. Design requirements – design windows and glass doors to withstand:
a. Wind loads in accordance with ASCE 7.
b. Movement caused by an ambient temperature range of 120°F and a surface temperature range of 160°F.

1.5 WARRANTY
A. Manufacturer:
1. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the aluminum window system and associated appurtenances.
2. Glazing: Provide a warranty for insulated units as specified in SECTION 08 80 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. EFCO Corporation, XTherm Series 325X
B. Kawneer Co., Inc., NX-300 Series
C. Peerless Products, Inc.
D. Wausau Window and Wall Systems, In Vent 325 Oi

2.2 COMPONENTS
A. Windows:
1. General:
a. Material – aluminum extrusions: In accordance with ASTM B 221, 6063-T6 commercial quality.
b. Frame and ventilator nominal minimum wall thickness: 0.070 inch.
c. Frame and ventilator member depth: Minimum 3 1/4 inches.
2. Frame: Components shall be mechanically fastened.
3. Ventilator:
a. Provide tubular ventilator extrusions.
b. Mitered corners, reinforced with extruded aluminum corner key, hydraulically crimp and cold weld with epoxy adhesive.
4. Weatherstripping: Neoprene, provide two rows installed in dovetail grooves in the ventilator extrusion.
5. Thermal barrier:
a. A rigid structural thermal barrier providing a separation between the interior and exterior aluminum surfaces:
1) Description: Two thermal struts, consisting of glass-reinforced polyamide nylon, mechanically crimped in the raceways extruded in the exterior and interior extrusions.
b. Mechanical fasteners, welded components, and hardware items shall not bridge thermal barriers.
6. Screens:
a. Frames: Extruded aluminum rigidly joined at corners, finish to match the windows.
b. Screen: The Manufacturer’s standard aluminum or fiberglass screen.
c. Provide extruded vinyl splines that are removable in order to permit re-screening.
d. Provide wicket in screen for access to window operating hardware.
7. Glazing: Units shall be glazed with the Manufacturer's standard sealant process provided the glass is held in place by a removable, extruded aluminum, glazing bead. The glazing bead shall be isolated from the glazing material by a gasket.
8. Glass and glazing accessories: As specified in SECTION 08 80 00.
9. Operating hardware:
a. Locking arms: Cam type white bronze alloy with an ANSI/BHMA A156.18, US25D brushed finish.
b. Projected sash: Anderberg Series 301, four bar balanced arm, zinc-plated, concealed hinges.

2.3 ACCESSORIES
A. Fasteners: SST, hot-dip galvanized steel, or fluoropolymer coated steel; use the type best suited to the application.
1. Visible screws, bolts, rivets, and other fastening devices shall match and blend with the finish of the member to which they are secured.

2.4 FABRICATION
A. Fabricate in accordance with AAMA/WDMA/CSA 101/I.S. 2/A440.
B. Fabricate with minimum clearances and shim spaces around perimeter while enabling installation and dynamic movement.
C. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.
D. Fabricate in the largest practicable units.
E. Weatherstrip the operable sash.

F. Fabricate aluminum components with an integral low conductance thermal barrier located between the exterior and the interior exposed components that eliminates metal-to-metal contact.
G. Conceal fasteners and attachments from view.
H. Reinforce the corners and intersections of frames and mullions.
I. Provide internal drainage weep holes and channels to route moisture to the exterior.
J. Form glass stops, exterior sills, closures, weatherstops, and flashings of the same material as the frame.
K. Mount screens in a removable, rewireable aluminum frame.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install windows and glass doors in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Set plumb, level, rigid, and free from warp or rack.
C. Anchor to supporting construction.
D. Installation Tolerances:
   1. Maximum variation from plumb or level: 1/8 inch in 3 feet or 1/4 inch in any 10 feet, whichever is less.
   2. Maximum misalignment of members abutting end to end: 1/32 inch.
E. Seal joints between units and substrate to provide a weathertight installation at opening perimeters as specified in SECTION 07 92 00.

3.2 ADJUSTING

A. Adjust for smooth operation.
B. Touch up minor scratches and abrasions to match the original finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 62 00
UNIT SKYLIGHTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for unit skylights.

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. 1607 – Voluntary Installation Guidelines for Unit Skylights
   2. 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

B. American Architectural Manufacturers Association/Window and Doors Manufacturers Association/CSA Group (AAMA/WDMA/CSA):
   1. 101/I.S.2/A440 – Specification for Windows, Doors, and Skylights

C. ASTM International (ASTM):
   1. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
   2. D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
   3. D 1929 – Standard Test Method for Determining Ignition Temperature of Plastics
   4. D 2843 – Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics

D. National Fenestration Rating Council (NFRC):
   1. 100 – Procedure for Determining Product U-factors.
   2. 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
   3. Certified Products Directory

1.3 SUBMITTALS

A. Product Data: The Manufacturer's product data and technical literature indicating:
   1. The models and sizes to be used.
   2. Technical information/details of construction.
   3. Indicate compliance with the performance requirements of the Contract Documents.

B. Shop Drawings: Project-specific plans, sections, details, including connections to supporting structure.

C. Samples:
   1. Aluminum finish: Manufacturer's standard size samples.
   2. Glazing: for each glazing component in Manufacturer's standard sizes.

D. Quality Control Submittal: A copy of the Manufacturer's warranty.

E. Warranty Documentation:
   1. Sample warranty.
   2. Warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. A minimum of 5 years of documented experience in the Work of this Section.
   2. Approved by the Manufacturer.

B. Coordination: Confirm and coordinate the final skylight dimensions and the required roof opening or curb dimensions.

C. Performance Requirements:
   1. Unit skylight standard: In accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
   2. Thermal performance: Tested and certified by NFRC for thermal performance.
   3. Structural performance: Provide unit skylights capable of withstanding loads as prescribed by the prevailing code for the project location.
   4. Thermal transmittance: NFRC 100 maximum U-factor of 0.36 Btu/hr-ft2-°F.
   5. Solar heat-gain coefficient: NFRC 200 maximum solar heat-gain coefficient of 0.31.
   6. Visible light transmittance: 40%.
   7. Fire-test-response characteristics, domes: Provide thermoformed domes fabricated from sheets identical to those tested for the following fire-test-response characteristics, in accordance with ASTM test method indicated, by UL or other testing and inspecting agencies acceptable to the AHJs.
      a. Self-ignition temperature: 651°F or greater tested in accordance with ASTM D 1929 on plastic sheets in the thickness intended for use.
      b. Smoke density: 75 or less tested in accordance with ASTM D 2843 on the plastic sheet thickness intended for use.
      c. Relative, burning: Burning extent of 2.5 in/minute or less: Tested in accordance with ASTM D 635 on plastic glazing with a nominal thickness of 0.060 inch or the thickness intended for use.
   8. Fire-test-response characteristics, polycarbonate: Provide a flat cellular polycarbonate panel fabricated from an approved cellular polycarbonate glazing (light transmitting) material identical to that tested with a CC1 fire rating classification in accordance with ASTM D 635 and filled with Lumira aerogel insulation in the thickness (0.3937 inch) intended for use.
      a. Self-ignition temperature: 1110 ºF or greater tested in accordance with ASTM D 1929 on multi-wall cellular panel filled with Lumira aerogel insulation in the thickness (0.3937 inch) intended for use.

1.5 WARRANTY

A. Warranty Requirements:

1. Skylight warranty: The Manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within 2 years from the date of Substantial Completion.
   a. Failures include, but are not limited to, the following:
      1) Uncontrolled water leakage.
      2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Plastic warranty: The Manufacturer agrees to repair or replace Work that has or develops defects in the plastic within 2 years from the date of Substantial Completion. Defects include abnormal aging, deterioration, yellowing, and breakage.
3. Finish warranty: The Manufacturer agrees to repair or replace Work with finish defects within 10 years from the date of Substantial Completion. Defects include peeling, chipping, chalking, fading, abnormal aging, deterioration, and failure to perform as required.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Wasco, a Velux company; Ecosky Model CLD3

B. Erogel Insulation:

1. Lumira

2.2 MATERIALS

A. Unit Skylight Materials:

1. Curb frame: High performance PVC with a minimum effective thickness of 0.060 inch. Provide an integral condensation gutter system with corners fully welded for waterproof quality.
2. Retainer frame: Extruded aluminum alloy 6063-T5 (min) in accordance with ASTM B 221, with a minimum thickness of 0.60 inch.
3. Integral curbs: Provide double skin of 1100-H14 sheet aluminum, insulated with 1 1/2 inch, R5.8, expanded polystyrene (EPS) insulation board. Provide thermal break at the top and bottom. Provide 0.025 inch minimum thickness inner and outer skin. Outer skin shall be 0.032-inch when length exceeds nominal 48 inches.
4. Dome glazing: Thermoformed impact modified acrylic glazing.
5. Interior laylite: 10 mm multi-wall flat cellular polycarbonate panel filled with Lumira aerogel insulating material.
6. Thermal break: Thermal chambered PVC.
7. Gaskets: Structural glazing tape shall form an adhesive bond between the PVC curb and the inner laylite, between the inner laylite and the inner dome, and between the inner dome and the outer dome. Butyl tape shall form and adhesive bond between the outer dome and the extruded aluminum retainer.

2.3 COMPONENTS

A. Unit Skylights: Factory-assembled deck-mounted unit skylights consisting of impact modified plastic glazing, and a polycarbonate panel filled with Lumira aerogel, including gasketing, extruded-aluminum glazing retainers, and an inner frame that is interlocked into the aluminum curb with a self-contained flashing flange.

B. Unit Shape and Size: As shown on the Drawings.

C. Glazing: Double dome impact modified plastic unit with a flat 0.3937 inch multiwall polycarbonate panel.

1. Outer glazing profile: Dome, 25% rise, thermoformable, monolithic sheet, category as standard with the Manufacturer.
   a. Thicknesses: Not less than the thicknesses required to exceed performance requirements.
   b. Color: White, translucent.
2. Middle glazing component: Dome, thermoformable, impact modified monolithic clear acrylic sheet, category as standard with the Manufacturer.
   a. Thicknesses: Not less than the thicknesses required to exceed performance requirements.
   b. Color: Clear.
3. Inner flat laylite glazing component: The Manufacturer's standard 10 mm multi-wall flat polycarbonate sheet with a cellular cross section that provides isolated airspaces and filled with Lumira aerogel insulation material.
   a. Thicknesses: 10 mm.

D. Thermal break: Thermal chambered PVC frame.

E. Condensation control: Full perimeter integral internal gutters and weeps to collect and dispose of condensation.

F. Integral Curb: The Manufacturer’s standard formed aluminum, self-flashing type, including flashing flange to receive roof flashing and counter flashing.

1. Height: 12 inches.
2. Construction: Double wall.
3. Insulation: The Manufacturer's standard rigid or semi-rigid type.

G. Security Screens: The Manufacturer's standard 0.156 inch diameter steel wires at 4 inches on center, welded at intersections, for installation between the curb and the skylight.

2.4 ACCESSORIES

A. Fasteners: The same metal as the metal being fastened, nonmagnetic SST, or other noncorrosive metal as recommended by the Manufacturer. Finish exposed fasteners to match the material being fastened.

B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15 mil DFT per coat.

2.5 FABRICATION

A. Skylights shall be factory assembled and glazed, ready for installation.

B. Fabricate components to drain condensation and moisture occurring or migrating within the skylight system to the exterior.

C. Fabricate components to ensure that glazing is thermally and physically isolated from framing members
D. Fabricate skylights weathertight and free of visual distortions and defects.
E. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
F. Seal glazing panels to the base frame with allowance for expansion and contraction.

2.6 FINISHES

A. Aluminum Finishes:
1. Kynar fluoropolymer two-coat system: 70% PVDF in accordance with AAMA 2605.
2. Color: As selected by the ENGINEER from Manufacturer's full range of standard colors.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates and conditions for compliance with the requirements for installation tolerances and other conditions affecting skylight performance.
B. Proceed with installation only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Completely erect and glaze in accordance with AAMA 1607 and the Manufacturer's instructions.
B. Install on the curb as shown on the Drawings.
C. Anchor units securely to supporting substrates that are adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.
D. Provide a protective coating to prevent electrolytic action on aluminum that comes in contact with dissimilar materials.
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by the Manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Where aluminum will contact pressure-treated wood, separate dissimilar materials by methods recommended by the Manufacturer.

3.3 CLEANING

A. Clean exposed metal and plastic surfaces in accordance with the Manufacturer's instructions. Touch up damaged metal coatings.
B. Clean plastic skylight units, inside and out, no more than 5 days prior to the Substantial Completion date.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 64 00
FIBERGLASS-SANDWICH-PANEL SKYLIGHT ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for fiberglass-sandwich-panel skylight assemblies.

B. Related Sections:

1. SECTION 05 05 23 – WELDING
2. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. 501.2 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems
2. 611 – Voluntary Specification for Anodized Architectural Aluminum
3. 1503 – Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections

B. American Society of Civil Engineers (ASCE):

1. 7 – Minimum Design Loads for Buildings and Other Structures

C. ASTM International (ASTM):

1. A 36 – Standard Specification for Carbon Structural Steel
2. A 193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
3. A 307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
4. B 85 – Standard Specification for Aluminum-Alloy Die Casting
5. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
7. C 297 – Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
8. D 395 – Standard Test Methods for Rubber Property – Compression Set
9. D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
10. D 865 – Standard Test Method for Rubber-Deterioration by Heating in Air (Test Tube Enclosure)
11. D 925 – Standard Test Methods for Rubber Property – Staining of Surfaces (Contact, Migration, and Diffusion)
12. D 1002 – Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
13. D 1037 – Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
14. D 1056 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber
15. D 1149 – Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment
16. D 1929 – Standard Test Method for Determining Ignition Temperature of Plastics
17. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
18. E 283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors, Under Specified Pressure Difference Across the Specimen
19. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
20. E 331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

D. Underwriters Laboratories (UL):

1. 972 – Standard for Burglary Resisting Glazing Material

1.3 SUBMITTALS

A. Product Data: Include material descriptions, product details, and finish data for systems components.

B. Shop Drawings:

1. Joining techniques, provision for expansion and contraction, anchorage details, and framing member profiles, elevations, and details.
2. Materials and finishes.
3. The relative layout of adjacent and supporting construction.
4. Translucent panels, setting blocks, jamb blocking, and glazing seals.
5. Weep drainage network.
6. Joint sealants, backer rods, bond breakers, and primers.
7. Loads applied to structure: Location, direction, and magnitude.

C. Samples:

1. Translucent panels: 12 inches by 12 inches showing the exterior and the interior skin color and the required light transmittance.
2. Finish samples: The Manufacturer's standard size color samples of each specified material showing the full range of available colors.

D. Quality Control Submittals:

1. Test reports: Certified results of previous tests by a recognized independent testing laboratory substantiating compliance with the specified design and performance criteria.
2. Welder qualifications: As specified in SECTION 05 05 23.

E. Warranty Documentation:
   1. Sample warranty.
   2. Warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. A minimum of 10 years of documented experience in the Work of this Section.
   2. Capable of providing field service representation during installation.
B. Installer Qualifications:
   1. A minimum of 5 years of documented experience in the Work of this Section.
   2. Approved by the Manufacturer.
C. Delegated Design: Design fiberglass-sandwich-panel assemblies, including engineering analysis by a qualified Professional Engineer, using performance requirements and design criteria specified.
D. Welder Qualifications: As specified in SECTION 05 05 23.
E. Mockup:
   1. Size: 4 feet wide by 8 feet high.
   2. Include attachments, framing, translucent panels, trim, and sealers.
   3. Locate where directed.
   4. The approved mockup may not remain as part of the Work.
F. Performance Requirements:
   1. System description: Translucent panel system of reinforced double-faced composite sandwich panels, thermally broken, with support framing, battens, cap strips, related flashings, anchorage, and attachment devices.
   2. General performance: Fiberglass-sandwich-panel assemblies shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction:
      a. Structural loads.
      b. Thermal movements.
      c. Movements of supporting structure.
      d. Dimensional tolerances of building frame and other adjacent construction.
      e. Failure includes, but is not limited to, the following:
         1) Deflection exceeding specified limits.
         2) Water leakage.
         3) Thermal stresses transferred to building structure.
         4) Noise or vibration created by wind, thermal, or structural movements.
         5) Loosening or weakening of fasteners, attachments, and other components.
   3. Structural loads:
      a. Wind loads: As shown on the Drawings.
      b. Design wind pressure in accordance with ASCE 7 and local building codes, tested in accordance with ASTM E 330. The system shall withstand the loads normal to the wall plane in accordance with the Contract Documents.
   4. Expansion and contraction: Design and install components with provisions for expansion and contraction due to a 100˚F temperature variation.
   5. Deflection and stress limits: Normal to the plane of the panels, deflection of framing members shall not exceed 1/120 of the span.
   6. Safety factors – allowable stresses shall incorporate the following safety factors unless otherwise specified:
      a. Load carrying members: 1.65.
      b. Load carrying fasteners: 2.0.
   7. Design of the system shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
   8. Uniform structural loading: No panel breakage or permanent damage to fasteners or system components, tested in accordance with ASTM E 330 at 1.5 times the positive and negative wind-load design pressure.
   9. Air infiltration: Maximum 0.01 cfm/sf, tested in accordance with ASTM E 283 at a pressure differential across assembly of 15 psf.
   10. Water penetration: No water penetration in accordance with AAMA 501.2, tested in accordance with ASTM E 331 at a minimum of 15.0 psf.
   11. CRF: Minimum 75, tested in accordance with AAMA 1503.

1.5 WARRANTY

A. Special Warranty: The Manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within the specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including, but not limited to, excessive deflection.
      b. Water leakage.
   2. Warranty period: 1 year from the Substantial Completion date.
B. Fiberglass-Sandwich-Panel Warranty: The Manufacturer agrees to replace panels that exhibit defects in materials or workmanship.
   1. Defects include, but are not limited to, the following:
      a. Fiberbloom.
      b. Delamination of coating, if any, from exterior face sheet.

c. Color change exceeding requirements.
d. Delamination of panel face sheets from panel cores.
2. Warranty period: 10 years from the Substantial Completion date.

C. Finish Warranty: The Manufacturer agrees to repair or replace components on which finishes fail within the specified warranty period. The warranty does not include normal weathering.
1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
2. Warranty period: 10 years from the Substantial Completion date.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Kalwall Corporation
B. Major Industries, Inc.

2.2 MATERIALS
A. Aluminum Components: Alloy and temper best suited to the application.
1. Extrusions: In accordance with ASTM B 221.
2. Sheet: In accordance with ASTM B 209.
3. Castings: In accordance with ASTM B 85.
B. Steel Shapes: In accordance with ASTM A 36.

2.3 COMPONENTS
A. Panels:
1. Description: Assembly of uniformly colored, translucent, thermoset, fiberglass reinforced polymer face sheets bonded under controlled heat and pressure, to produce a straight full width consistent bonding line, to both sides of a mechanically interlocked aluminum I- beam grid core to form double-faced self-supporting sandwich panels.
2. Size: 2 3/4 inches deep.
3. Nominal grid size: 12 inches by 24 inches.
4. Grid pattern: In-line Shoji.
5. Colors:
a. Exterior sheet: Crystal.
b. Interior sheet: White.
6. Thermal resistance: U-value of no more than 0.23 Btu/sf/hr/°F.
7. Visible light transmittance: 25% minimum.
8. Solar heat gain coefficient: 0.31 maximum.
9. I-beam grid core:
a. Material: In accordance with ASTM B 221, 6061-T6, aluminum-alloy.
b. Flange width: 7/16 inch minimum.
c. Web thickness: 0.050 inch.
d. Mechanically interlocked.
e. Full surface contact with face sheets.
f. Thermal break:
1) Located in the panel grid core.
2) Poured and debridged structural polyurethane, insulating U-factor of 0.5.
10. Panel weeps: Weep holes provided on the down slope side for skylights or the bottom side of wall systems of installed panels to permit condensation to leave the interior of the panel.
11. Adhesive:
a. Laminate adhesive: Waterproof resin for use in laminating the polyester sheet to the aluminum grid core.
b. Impact and thermal shock: Adhesive capable of withstanding impact and thermal shock normally encountered in exterior construction.
c. Adhesive bond line: Straight, black, and cover the entire width of the I-beam with a neat, sharp edge.
d. Initial bond strength between face sheet and grid core:
1) Shear strength: 563 psi minimum in accordance with ASTM D 1002.
2) Tensile strength: 557 psi minimum in accordance with ASTM C 297.
e. Aged adhesive bond strength, in accordance with ASTM D 1037: Tensile strength 900 psi, minimum, in accordance with ASTM C 297, shear strength 1,200 psi minimum in accordance with ASTM D 1002.
12. Exterior face sheet:
a. Darkening: Color change on the exterior sheet shall not exceed 3.0 Delta E units after 5 years of South Florida (or accelerated test equivalent) weathering.
b. Impact strength: UL 972, 70 ft-lbs impact energy.
c. Thickness: 0.070 inch.
d. Color: Crystal.
e. Protective weathering surface: Self-cleaning thermoset acrylic urethane surface molecularly bonded under factory-controlled conditions, minimum thickness: 1 mil, fully field repairable.
13. Interior face sheet:
a. Flame spread, in accordance with ASTM E 84: 25 maximum.
b. Smoke development, in accordance with ASTM E 84: 300 maximum.
c. Burn rate, in accordance with ASTM D 635: 1 in/minute maximum.
d. Self-ignition, in accordance with ASTM D 1929: Greater than 650°F.
e. Thickness: 0.045 inch.

f. Color: White.

B. Framing Materials:
1. Aluminum:
a. Extruded aluminum: In accordance with ASTM B 221, Alloy 6063-T5/T6, 6061-T5/T6.
b. Formed aluminum components and flashing: In accordance with ASTM B 209, Alloy 5005-H34.
c. Minimum thickness: 0.040 inch.
2. Interior glazing gaskets:
a. Extruded closed-cell sponge neoprene hybrid, 9/16 inch wide.
b. Factory-installed in extruded dovetail slots.
c. Compression deflection, 25% deflection limits, in accordance with ASTM D 1056, 13 psi to 24 psi.
d. Compression set, 22 hours at 158°F, maximum percent, in accordance with ASTM D 395, Method B: 30 psi.
e. Heat aging, 70 hours at 212°F, change in compression values, in accordance with ASTM D 865 and ASTM D 1056: 0 psi to 10 psi.
f. Ozone resistance at 40% elongation, 100 hours at 104°F, in accordance with ASTM D 1149:
1) Type I, 1 ppm ozone: No cracks.
2) Type II, 3 ppm ozone: No cracks.
g. Staining of surface, in accordance with ASTM D 925: Nonstaining, no migratory stain.

C. Exterior Skylight Glazing Gaskets: Butyl tape with integral PP backer rod, factory-installed.

D. Condensation Control System:
1. Mechanically design the entire system to function properly with minimal dependency upon the sealants.
2. Weep holes in sill components: Located as required to control condensation that may enter the system by allowing it to pass to the exterior.

E. Glazing Caps:
1. Extruded aluminum.
2. Attach with glazing cap fasteners located at a maximum of 12 inches on center or as required to resist negative loading.

2.4 ACCESSORIES

A. Fasteners: The Manufacturer's standard corrosion-resistant, non-staining type recommended for application.
1. ASTM A 193 series 300 SST for wet locations and exposed fasteners.
2. Stainless or corrosion-resistant coated steel for other locations.
3. Exposed fasteners: The finish shall match the aluminum.

B. Joint Sealants: As specified in SECTION 07 92 00 for the perimeter.

C. Anchor bolts: In accordance with ASTM A 307, Grade A galvanized steel.

D. Exposed flashing and closures: Aluminum sheet not less than 0.050 inch thick, finished to match framing.

E. Primer Paint: Zinc-rich type.

2.5 FABRICATION

A. Fabricate with minimum clearances and shim spaces around the perimeter while enabling installation and dynamic movement.

B. Accurately fit and secure joints and intersections. Make joints flush, hairline, and weathertight.

C. Fabricate in the largest practicable units.

D. Conceal fasteners and attachments from view.

E. Reinforce framing members with internal steel when required to support imposed loads.

F. Fabricate so that components will not be excessively strained under the normal conditions of use.

G. Provide slotted holes for erection adjustment.

H. Provide fascias, covers, closures, and trim members that are attached to the translucent panel system.

I. Make provisions in the design to drain to the exterior any leakage of water occurring at joints and condensation taking place within construction. Provide gutters at horizontals at the bottom of panels; weep to exterior through baffled weep holes.

J. Fabricate aluminum components with an integral low conductance thermal barrier located between the exterior and the interior exposed components that eliminates metal-to-metal contact.

2.6 FINISHES

A. Aluminum: In accordance with AAMA 611 (AA-M10-C22-A42) Architectural Class I anodized to 0.0007 inch minimum thickness, bronze color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.

B. Install components plumb and level, in the proper plane, free from warp and twist.

C. Anchor to supporting construction.

D. Weld adjustable anchorage connections after the translucent panel system is properly positioned. Perform welding in accordance with the Manufacturer's instructions.

E. Compensate for predictable conditions that could cause the system to exceed the allowable tolerances.

F. Accommodate thermal and mechanical movements.

G. Employ reinforcing members if required. If temporary braces or erection clips are used, prevent damage to exposed surfaces.

H. Install components including flashings, fasteners, hardware, sealants, and glazing materials required for a complete, weatherproof installation.

I. Install framing components to drain water-passing joints and to drain condensation and moisture occurring or migrating within the skylight system to the exterior.

J. Installation Tolerances:

1. Variation from plane or locations shown on the Shop Drawings: Maximum 1/8 inch in 10 feet of length or 1/2 inch in any total length.
2. Offset from true alignment between two identical members abutting end to end in line: Maximum 1/32 inch.
3. Joint sealant space between translucent panel system and adjacent construction: 1/4 inch, ±1/8 inch.

3.2 CLEANING

A. No more than 5 days prior to the Substantial Completion date, clean panels and components inside and outside, immediately after installation, and after sealants have cured, in accordance with the Manufacturer's recommendations.

B. No more than 5 days prior to the Substantial Completion date, remove temporary protective coverings and strippable coatings from prefinished metal surfaces. Remove labels and markings from components.

3.3 ADJUSTING

A. Touch up minor scratches and abrasions on finished surfaces to match the original finish.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for door hardware.

B. Related Sections:

1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
3. SECTION 01 40 00 – QUALITY REQUIREMENTS
4. SECTION 01 44 33 – MANUFACTURER'S SERVICES
5. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
6. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA

1.2 REFERENCES

A. ASTM International (ASTM):

1. E 283 – Standard Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

B. Builders Hardware Manufacturers Association (BHMA):

1. A156.1 – Butts and Hinges
2. A156.2 – Bored and Preassembled Locks & Latches
3. A156.3 – Exit Devices
4. A156.4 – Door Controls - Closers
5. A156.5 – Cylinders and Input Devices for Locks
6. A156.6 – Architectural Door Trim
7. A156.8 – Door Controls - Overhead Stops and Holders
8. A156.14 – Sliding and Folding Door Hardware
9. A156.15 – Release Devices-Closer Holder, Electromagnetic and Electromechanical
10. A156.16 – Auxiliary Hardware
11. A156.18 – Materials and Finishes
12. A156.21 – Thresholds
13. A156.22 – Door Gasketing and Edge Seal Systems
14. A156.25 – Electrified Locking Devices
15. A156.26 – Continuous Hinges
16. A156.28 – Recommended Practices for Mechanical Keying Systems
17. A156.31 – Electric Strikes and Frame Mounted Actuators

C. Door and Hardware Institute (DHI):

1. WDHS.2 – Recommended Fasteners for Wood Doors
2. WDHS.3 – Recommended Hardware Locations for Wood Flush Doors
3. WDHS.5 – Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors

D. Hollow Metal Manufacturers Association (HMMA):

1. 831 – Hardware Locations for Hollow Metal Doors and Frames

E. National Fire Protection Association (NFPA):

1. 70 – National Electrical Code
2. 80 – Standard for Fire Doors and Other Opening Protectives
3. 105 – Standard for Smoke Door Assemblies and Other Opening Protectives
4. 252 – Standard Methods of Fire Tests of Door Assemblies

F. Steel Door Institute (SDI):

1. A250.6 – Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames

G. Underwriters Laboratories, Inc. (UL):

1. 10C – Safety Positive Pressure Fire Tests of Door Assemblies
2. 1784 – Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives

1.3 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other Work specified to be factory prepared. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with the OWNER's security requirements.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.4 SUBMITTALS

A. Submit the following as specified in SECTION 01 33 00.

1. Warranty documentation as specified in SECTION 01 60 00.
2. O&M documentation as specified in SECTION 01 78 23.

B. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles and finishes.

C. Shop Drawings: Details of electrified door hardware indicating the following:

1. Wiring diagrams for power, signal, and control wiring and including the following:
   a. Details of interface of electrified door hardware and building safety and security systems.

b. Schematic diagram of systems that interface with electrified door hardware.
c. Point-to-point wiring.
d. Riser diagram.
e. Elevations of doors controlled by electrified door hardware.

2. Operation narrative: Describe the operation of doors controlled by electrified door hardware.

D. Other Action Submittals:
1. A door hardware schedule prepared by or under the supervision of the Installer, detailing fabrication and assembly of door hardware, installation procedures, and diagrams. Coordinate final door hardware schedule with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish of door hardware.
2. Use the same scheduling sequence and format and use the same door numbers as in the Contract Documents.
3. The format shall be in accordance with the scheduling sequence and vertical format in DHI's Sequence and Format for the Hardware Schedule. Double space entries, and number and date each page.
4. Include the following information:
a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Complete designations, including name and Manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
c. Locations of each door hardware set cross-referenced to the Drawings on floor plans and to the door and frame schedule.
d. Fastenings and other pertinent information.
e. Explanation of abbreviations, symbols, and codes contained in the schedule.
f. Mounting locations for door hardware.
g. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
h. Door and frame sizes and materials.

E. Submittal Sequence: Submit the door hardware schedule concurrent with submissions of product data and Shop Drawings. Submit the schedule at the earliest possible date to facilitate a coordinated review of the hardware schedule. Coordinate submission of the door hardware schedule with scheduling requirements of other Work to precede the fabrication of other Work that is critical in the project construction schedule.

F. Keying Schedule: Prepared by or under the supervision of the Installer, detailing the OWNER's final keying instructions for locks. Include a schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

G. Product Certificates: For electrified door hardware, from the Manufacturer.

H. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

I. Maintenance Data: As specified in SECTION 01 78 23, furnish data for each type of door hardware to include in maintenance manuals. Include a final hardware schedule.

J. Each manual shall consist of printed sheets from the Hardware Manufacturer.

K. Maintenance instruction and parts list for each type of operating hardware listed including:
1. Locks.
2. Exit devices.
3. Closers.

L. O&M Special Requirements:
1. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02). Specific requirements in addition to these Sections shall include the following:
a. Maintenance tools and instructions: Furnish a complete set of specialized tools and maintenance instructions for the OWNER's continued adjustment, maintenance, and removal and replacement of door hardware.
b. Maintenance service: Beginning at Substantial Completion, provide 6 months full maintenance by skilled employees of the Door Hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

1.5 QUALITY ASSURANCE

A. As specified in SECTION 01 40 00.

B. Installer Qualifications: The supplier of products and an employer of workers trained and approved by product Manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with the CONTRACTOR, ENGINEER, and OWNER about door hardware and keying.

C. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this project and who is currently certified by DHI as follows:
1. For door hardware, an Architectural Hardware Consultant.

D. Source Limitations: Obtain each type of door hardware from a single Manufacturer.
1. Provide electrified door hardware from the same Manufacturer as mechanical door hardware, unless otherwise indicated.

E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for the fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C, unless otherwise indicated.

F. Smoke-Control and Draft-Control Door Assemblies: Where smoke-control and draft-control door assemblies are required, provide door hardware that meets the requirements of assemblies tested in accordance with UL 1784 and installed in accordance with NFPA 105.
   1. Air leakage rate: Maximum air leakage of 0.3 cfm/sf at the tested pressure differential of 0.3 inch water gauge of water.

G. Electrified Door Hardware: Listed and labeled in accordance with NFPA 70, ARTICLE 100, by a testing agency acceptable to the AHJs.
   1. Provide plug connector applications. Furnish wire harnesses for internal transfers and as required for access system final connections.

H. Means of Egress Doors: Latches do not require more than 15 pound-force (67 Newton) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, in accordance with ICC/ANSI A117.1.
   1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 pound-force (22.2 Newton).
   2. Comply with the following maximum opening-force requirements:
      a. Interior, non-fire-rated hinged doors: 5 pound-force (22.2 Newton) applied perpendicular to door.
      b. Sliding or folding doors: 5 pound-force (22.2 Newton) applied parallel to door at latch.
      c. Fire doors: Minimum opening force allowable by the AHJs.
   3. Bevel raised thresholds with a slope of not more than 1 to 2. Provide thresholds not more than 1/2 inch high.
   4. Adjust door closer sweep periods so that from an open position of 70 degrees the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

J. Keying Conference: Conduct a conference at the project site. In addition to the OWNER, CONTRACTOR, and ENGINEER, conference participants shall also include the Installer's Architectural Hardware Consultant and the OWNER's security personnel. Incorporate keying conference decisions into the final keying schedule after reviewing the door hardware keying system including, but not limited to, the following:
   1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
   2. Preliminary key system schematic diagram.
   3. Requirements for key control system.
   4. Requirements for access control.
   5. Address for the delivery of keys.

K. Training requirements for Manufacturer’s training on the equipment shall be as specified in SECTION 01 44 33.

1.6 DELIVERY, STORAGE, AND HANDLING

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
   1. Inventory door hardware on the receipt and provide secure lock-up for door hardware delivered to the project site.
   2. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
   3. Deliver keys and permanent cores to the OWNER by hand delivery, registered mail, or overnight package service.

1.7 WARRANTY

A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
   1. Special warranty: The Manufacturer's standard form in which the Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within the specified warranty period.
      a. Failures include, but are not limited to, the following:
         1) Structural failures including excessive deflection, cracking, or breakage.
         2) Faulty operation of doors and door hardware.
         3) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty period: 2 years from date of Substantial Completion, except as follows:
      a. Mechanical locks and cylinders: Limited lifetime from the date of Substantial Completion.
      b. Exit devices: 5 years from the date of Substantial Completion.
      c. Manual closers: 10 years from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Hinges:
   1. Bommer Industries, Inc.
   2. Hager Companies
   3. McKinney Products Company; an ASSA ABLOY Group company
   4. Stanley Commercial Hardware; a Dormakaba Group company

B. Continuous Hinges:
   1. Pin-and-Barrel-Type Hinges:
      a. Hager Companies
      b. IVES Hardware; an Ingersoll-Rand company
      c. Lawrence Hardware Inc.
      d. Markar Architectural Products, Inc.; a subsidiary of Adams Rite Manufacturing Co.
      e. McKinney Products Company; an ASSA ABLOY Group company
      f. Select Products Limited
      g. Zero International

2. Continuous, Gear-Type Hinges:
    a. ABH Manufacturing Inc.
    b. Bommer Industries, Inc.
    c. Cal-Royal Products, Inc.
    d. Hager Companies
    e. IVES Hardware; an Ingersoll-Rand company
    f. McKinney Products Company; an ASSA ABLOY Group company
    g. Select Products Limited
    h. Stanley Commercial Hardware; a Dormakaba Group company
    i. Zero International

C. Mechanical Locks and Latches:
1. Bored Locks:
    a. Best Access Systems; a Dormakaba Group company

D. Auxiliary Locks:
1. Bored Auxiliary Locks:
    a. Best Access Systems; a Dormakaba Group company
2. Mortise Auxiliary Locks:
    a. Best Access Systems; a Dormakaba Group company

E. Electric Strikes:
1. Folger Adam Electric Door Controls; an ASSA ABLOY Group company
2. HES, Inc.; an ASSA ABLOY Group company
3. Rutherford Controls Int'l. Corp.
4. Security Door Controls
5. Von Duprin; an Ingersoll-Rand company

F. Push/Pull Units:
1. Trimco
2. Hiawatha
3. Metalcraft

G. Electromechanical Locks:
1. Best Access Systems; a Dormakaba Group company

H. Manual Flush Bolts:
1. Burns Manufacturing Incorporated
2. Don-Jo Mfg., Inc.
3. Door Controls International, Inc.
4. Hiawatha, Inc.
5. IVES Hardware; an Ingersoll-Rand company
6. Trimco

I. Automatic And Self-Latching Flush Bolts:
1. Door Controls International, Inc.
2. IVES Hardware; an Ingersoll-Rand company
3. Trimco

J. Exit Devices and Auxiliary Items:
1. Precision Hardware, Inc.; a Dormakaba Group company
2. Von Duprin; an Ingersoll-Rand company

K. Lock Cylinders:
1. Best Access Systems; a Dormakaba Group company

L. Key Control System:
1. Key control cabinet:
    a. American Key Boxes and Cabinets
    b. GE Security, Inc.
    c. HPC, Inc.
    d. Lund Equipment Co., Inc.
    e. MMF Industries
    f. Tri Palm International

M. Operating Trim:
1. Burns Manufacturing Incorporated
2. Don-Jo Mfg., Inc.
3. Forms + Surfaces
4. Hager Companies
5. Hiawatha, Inc.
6. IVES Hardware; an Ingersoll-Rand company
7. Rockwood Manufacturing Company
8. Trimco

N. Closers:
1. Surface closers:
    a. LCN Closers; an Ingersoll-Rand company, 4040XP
    b. Best Door Closers, HD8016

O. Mechanical Stops and Holders:
   1. Wall-mounted and floor-mounted stops:
      a. Architectural Builders Hardware Mfg., Inc.
      b. Burns Manufacturing Incorporated
      c. Cal-Royal Products, Inc.
      d. Don-Jo Mfg., Inc.
      e. Door Controls International, Inc.
      f. Hager Companies
      g. Hiawatha, Inc.
      h. IVES Hardware; an Ingersoll-Rand company
      i. Rockwood Manufacturing Company
      j. Trimco
P. Electromagnetic Stops and Holders:
   1. Architectural Builders Hardware Mfg., Inc.
   2. DORMA Architectural Hardware; Member of The DORMA Group North America
   3. SARGENT Manufacturing Company; an ASSA ABLOY Group company
Q. Overhead Stops and Holders:
   1. Architectural Builders Hardware Mfg., Inc.
   2. Glynn-Johnson; an Ingersoll-Rand company
   3. Rockwood Manufacturing Company
   4. SARGENT Manufacturing Company; an ASSA ABLOY Group company
R. Door Gasketing:
   1. Hager Companies
   2. National Guard Products
   3. Pemko Manufacturing Co., an ASSA ABLOY Group company
   4. Reese Enterprises, Inc.
   5. Sealeze, a unit of Jason Incorporated
   6. Zero International
S. Thresholds:
   1. Hager Companies
   2. National Guard Products
   3. Pemko Manufacturing Co.; an ASSA ABLOY Group company
   4. Reese Enterprises, Inc.
   5. Rixson Specialty Door Controls; an ASSA ABLOY Group company
   6. Sealeze; a unit of Jason Incorporated
   7. Zero International
T. Sliding Door Hardware:
   1. Cox, Arthur, & Sons, Inc.
   2. Hager Companies
   3. Henderson, PC Inc.
   4. Johnson, L. E., Products, Inc.
   5. Stanley Commercial Hardware; a Dormakaba Group company
   6. Protection plates:
      a. Hager
      b. Trimco
   7. Fasteners: Provide the Manufacturer's standard exposed fasteners for door trim units. Machine screws or self-tapping screw.
U. Lock Protectors:
   1. Trimco 5002
   2. Precision
   3. Latch Guard
V. Metal Protective Trim Units:
   1. Baldwin Hardware Corporation
   2. Burns Manufacturing Incorporated
   3. Don-Jo Mfg., Inc.
   4. Hiawatha, Inc.
   5. IPC Door and Wall Protection Systems, Inc.; Div. of InPro Corporation
   6. IVES Hardware; an Ingersoll-Rand company
   7. Pawling Corporation
   8. Rockwood Manufacturing Company
   9. Trimco
W. Auxiliary Door Hardware:
   1. Don-Jo Mfg., Inc.
   2. Hager Companies
   3. Rockwood Manufacturing Company
   4. Stanley Commercial Hardware; a Dormakaba Group company
   5. Trimco

X. Auxiliary Electrified Door Hardware:
   1. GE Security, Inc.
   2. Securitron Magnalock Corporation; an ASSA ABLOY Group company
   3. Security Door Controls

2.2 COMPONENTS

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

B. Continuous Hinges:
   1. Continuous hinges: BHMA A156.26; minimum 0.120 inch thick, hinge leaves with minimum overall width of 4 inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
   2. Continuous, gear-type hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.

C. Mechanical Locks and Latches:
   1. Lock functions: As indicated in the door hardware schedule in this Section.
   2. Lock throw: Comply with testing requirements for the length of bolts required for labeled fire doors, and as follows:
      a. Bored locks: Minimum 1/2-inch latchbolt throw.
   3. Lock backset: 2 3/4 inches, unless otherwise indicated.
   4. Lock trim:
      a. Levers: Cast.
         1) Best 15D.
      b. Escutcheons (roses): Wrought.
      c. Dummy trim: Match lever lock trim and escutcheons.
      d. Operating device: Lever with escutcheons (roses).
   5. Strikes: Provide the Manufacturer's standard strike for each lock bolt or latchbolt complying with the requirements indicated for the applicable lock or latch and with the strike box and curved lip extended to protect the frame; finished to match lock or latch.
      a. Flat-lip strikes: For locks with three-piece antifriction latchbolts, as recommended by the Manufacturer.
      b. Extra-long-lip strikes: For locks used on frames with applied wood casing trim.
      c. Aluminum-frame strike box: The Manufacturer's special strike box fabricated for aluminum framing.
      d. Rabbet front and strike: Provide on locksets for rabbeted meeting stiles.
   6. Bored locks: BHMA A156.2; Grade 1; Series 4000.

D. Auxiliary Locks:
   1. Bored auxiliary locks: BHMA A156.5: Grade 1; with strike that suits frame.

E. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

F. Push/Pull Units: Where door pulls are scheduled on one side of the door and push plates on the other side issue installation instructions to ensure the pull is secured through the door from the reverse side and countersunk flush with the door installation of the push plate. Locate the push plate to cover fasteners for door pulls.

G. Electromechanical Locks: BHMA A156.25; Grade 1; motor or solenoid driven; bored; with a strike that suits the frame.

H. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into the door edge.

I. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into the door edge.

J. Exit Devices and Auxiliary Items:
   1. Exit devices and auxiliary items: BHMA A156.3.
   2. Lock cylinders: Tumbler type, constructed from brass or bronze, SST, or nickel silver.
   3. Standard lock cylinders: BHMA A156.5; Grade 1; permanent cores that are interchangeable; face finished to match the lockset.
   4. Construction cores: Provide construction cores that are replaceable by permanent cores. Provide ten construction master keys.

K. Keying:
   1. Keying system: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in the keying conference.
      a. Grand master key system: Change keys, a master key, and a grand master key to operate cylinders.
      b. Existing system: Master key or grand master key locks to the OWNER's existing system.
   2. Keys: Nickel silver.
      a. Permanently inscribe each key with a visual key control number and include the following notation: "DO NOT DUPLICATE."
      b. In addition to one extra key blank for each lock, provide the following:
         1) Cylinder change keys: Three.
         2) Master keys: Five.
         3) Grand master keys: Five.
         4) Great-grand master keys: Five.

L. Key Control System:
   1. Key control cabinet: BHMA A156.5; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with a key capacity of 150% of the number of locks.
      a. Wall-mounted cabinet: Cabinet with hinged-panel door equipped with key-holding panels and a pin-tumbler cylinder door lock.
   2. Key lock boxes: Designed for the storage of two keys.
   3. Cross-index system: A single-index system for recording key information. Include three receipt forms for each key-holding hook. Set up by the Installer.

M. Operating Trim: BHMA A156.6; brass or bronze, unless otherwise indicated.

N. Accessories for Pairs of Doors:
   1. Coordinators: BHMA A156.3; consisting of an active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
   2. Carry-open bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with a strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
   3. Astragals: BHMA A156.22.

O. Closers:
   1. Surface closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and a forged-steel main arm. Comply with the Manufacturer's recommendations for the size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
   2. Mechanical stops and holders:
      a. Wall-mounted and floor-mounted stops: BHMA A156.16; cast brass or bronze, base metal.
   3. Electromagnetic stops and holders: BHMA A156.15, Grade 1; a wall-mounted electromagnetic single unit with a strike plate attached to the swinging door; coordinated with fire detectors and interfaced with the fire alarm system for labeled fire-rated door assemblies.
   4. Overhead tops and holders: BHMA A156.8.

P. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested in accordance with ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by the Manufacturer.

Q. Thresholds: BHMA A156.21; fabricated to the full width of the opening indicated.

R. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including the rails, hangers, supports, bumpers, floor guides, and accessories indicated.

S. Folding Door Hardware: BHMA A156.14; complete sets including the overhead rails, hangers, supports, bumpers, floor guides, and accessories indicated.

T. Protection Plates:
   1. Fasteners: Provide the Manufacturer’s standard exposed fasteners for door trim units. Machine screws or self-tapping screws.
   2. Fabricate protection plates (armor, kick, or mop) not more than 1 1/2 inches less than the door width on the stop side and not more than 1/2 inch less than the door width on the pull side, by the height indicated.
      a. Metal plates: SST, 0.050 inch (U.S. 18 gauge) beveled edges, with countersunk screw holes of intervals of not over 6 inches on all four sides.

U. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050 inch thick chrome that is plated; with the Manufacturer's standard machine or self-tapping screw fasteners.

V. Auxiliary Door Hardware: BHMA A156.16.

W. Auxiliary Electrified Door Hardware: BHMA A156.25.

2.3 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have the Manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise accepted by the ENGINEER.
   1. The Manufacturer's identification is permitted on the rim of lock cylinders only.

B. Base Metals: Produce door hardware units of the base metal indicated, fabricated by the forming method indicated, using the Manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of the specified door hardware units and in accordance with BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws in accordance with commercially recognized industry standards for the application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match the surface of door hardware, unless otherwise indicated.
   1. Concealed fasteners: For door hardware units that are exposed when the door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where the bolt head or nut on the opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
   2. Fire-rated applications:
      a. Wood or machine screws for the following:
         1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors.
         2) Strike plates to frames.

3) Closers to doors and frames.
b. Steel through bolts for the following unless door blocking is provided:
1) Surface hinges to doors.
2) Closers to doors and frames.
3) Surface-mounted exit devices.
3. Spacers or sex bolts: For through bolting of hollow metal doors.
4. Fasteners for wood doors: In accordance with DHI WDHS.2.
5. Gasketing fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.4 FINISHES

A. Provide finishes in accordance with BHMA A156.18 as indicated in the door hardware schedule.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of accepted samples. Noticeable variations in the same piece are not acceptable. Variations in the appearance of other components are acceptable if they are within the range of accepted samples and are assembled or installed to minimize contrast.

2.5 SPARE PARTS REQUIREMENTS

A. Shipment requirements for spare parts as specified in SECTION 01 60 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Examination:
1. Examine doors and frames with the Installer present for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Preparation:
1. Steel doors and frames: For surface applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.
2. Wood doors: In accordance with DHI WDHS.5.

3.2 INSTALLATION

A. Mount door hardware units at heights in accordance with the following standards unless otherwise indicated or required to comply with governing regulations.
1. Custom steel doors and frames: HMMA 831.
2. Wood doors: DHI WDHS.3.
B. Install each door hardware item to comply with the Manufacturer's instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with interior finishing Work. Do not install surface-mounted items until finishes have been completed on the substrates involved.
1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
C. Install hinges in the types and in quantities indicated in the door hardware schedule but not fewer than the number recommended by the Manufacturer for the application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for the door, such as spring hinges or pivots, are provided.
D. Lock Cylinders: Install construction cores to secure the building and areas during the construction period.
1. Replace construction cores with permanent cores as directed by the OWNER.
2. Furnish permanent cores to the OWNER for installation.
E. Tag keys and place them on markers and hooks in the key control system cabinet, as determined by the final keying schedule.
F. Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify the location with the ENGINEER.
1. Provide one power supply for each door opening with electrified door hardware.
G. Set thresholds for exterior doors and other doors indicated in a full bed of sealant as specified in SECTION 07 92 00.
H. Provide floor stops for doors unless wall or other type stops are indicated in the door hardware schedule. Do not mount floor stops where they will impede traffic.
I. Apply perimeter gasketing to the head and the jamb, forming a seal between the door and the frame.
J. Meeting Stile Gasketing: Fasten to meeting stiles, forming a seal when the doors are closed.
K. Door Bottoms: Apply to the bottom of the door, forming a seal with the threshold when the door is closed.

3.3 QUALITY CONTROL

A. ORT Prerequisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting, or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER, shall be paid by the CONTRACTOR.

B. Architectural Hardware Consultant: The OWNER will engage a qualified, independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
   1. The Architectural Hardware Consultant shall inspect door hardware and state in each report if the installed Work complies with or deviates from requirements, including if door hardware is properly installed and adjusted.

3.4 CLEANING
A. Clean adjacent surfaces soiled by door hardware installation.
B. Clean operating items as necessary to restore proper function and finish.
C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at the time of Substantial Completion.

3.5 ADJUSTING
A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure the proper operation or function of the unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and in accordance with referenced accessibility requirements.
   1. Spring hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
   2. Electric strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   3. Door closers: Adjust sweep period to comply with accessibility requirements and requirements of the AHJs.
B. Occupancy Adjustment: Approximately 6 months after the date of Substantial Completion, the Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary, to ensure function of doors, door hardware, and electrified door hardware.

3.6 DOOR HARDWARE SCHEDULE
A. The schedule is a partial list to establish quality and clarify the hardware requirements of certain items.
B. Provide fasteners, accessories, and other devices required for complete and proper installation for each particular location.
C. The Manufacturer's reference number indicated is the first Manufacturer on the Manufacturer's list.
D. See the door schedule on the Drawings for the hardware group application.

Manufacturer List

Code	Name
AB	ABH MANUFACTURING INC.
BE	BEST ACCESS SYSTEMS
BY	BY OTHERS
DM	DORMA DOOR CONTROLS
NA	NATIONAL GUARD
PR	PRECISION
RC	RUTHERFORD CONTROLS
SD	STANLEY DOOR CLOSERS
SE	SENTROL
ST	STANLEY
TR	TRIMCO

Option List

Code	Description
S3	ANSI STRIKE PACKAGE
SN	SEX NUTS (PKG. OF 4)
AVB	ADVANCED VARIABLE BACKCHECK
CSK	COUNTER SINKING OF KICK AND MOP PLATES
SIA	ABRASIVE COATING-5" WIDTH-AL OR SST
R704	STRAIGHT CYLINDER RING - 1/4"
R708	STRAIGHT CYLINDER RING - 1/2"
R804	TAPERED CYLINDER RING - 1/4"
S301	OPT. ROLLER. STRK - RIM AND TOP OF SVR
SNB (2)	SEX BOLTS (2)
SSMS/LA	STAINLESS MACHINE SCREWS/LEAD ANCHOR

Finish List

Code	Description
D	BRONZE ANODIZED ALUMINUM
AL	ALUMINUM
626	SATIN CHROMIUM PLATED
628	SATIN ALUMINUM, CLEAR ANODIZED
630	SATIN SST
689	ALUMINUM PAINTED

Code	Description
626W	WEATHERIZED SATIN CHROME
GREY	GREY
626AM	SATIN CHROME - ANTIMICROBIAL COATING
US26D	CHROMIUM PLATED, DULL
US32D	SST, DULL

Hardware Sets

SET #1 - HM - (TYPICAL BLDG ENTRY – SGL DOOR - W/CARD READER)

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	HD8016 S DS SN AVB	689	BE
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #2 - HM - (TYPICAL BLDG ENTRY – PAIR DOORS - W/CARD READER)

8	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	E/Removable Mullion	1340 KR EL	600	DM
1	Mortise Cylinder (Mull)	1E-74 PATD	626	BE
1	Exit Device	3RO 2101 X 1701 S301 SNB (2)	626W	PR
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
2	Door Closer | Stop	HD8016 S DS SN AVB	689	BE
1	Mullion Seal	5100 S		NA
1	Weatherstrip	700 ES (HEAD & JAMBS) - PR		NA
1	Drip Cap	16 A - 4" ODW		NA
1	Threshold	896HD x SSMS/LA - PR	AL	NA
2	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #3 - HM - (TYPICAL PROCESS EXTERIOR ENTRY – SGL DOOR - W/CARD READER)

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Storeroom Lock	9K3-7D15D PATD S3	626	BE
1	Electric Strike	F1114	630	RC
1	Door Closer | C/Stop | HO	8016 S DST SN AVB	689	BE
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #4 – HM - (TYPICAL OFFICE BLDG ENTRY – SGL DOOR - 180 DEGREE - W/CARD READER)

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 1703A S301 SNB (2)	630	PR
1	Rim Cylinder	12E-72 PATD R804	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer	HD8016 SPA AVB SN	689	BE
1	Kick Plate	K0050 - 10" x 2" LDW CSK	630	TR
1	Wall Bumper	1270CX	626	TR
1	Drip Cap	16 A - 4" ODW		NA
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Threshold	896HD S x SSMS/LA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC

1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #5 – HM - (TYPICAL BLDG INTERIOR EGRESS – SGL DOOR - W/CARD READER)

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US26D	ST
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	626W	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer | Stop	HD8016 S DS SN	689	BE
3	Door Silencers	1229A	GREY	TR
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #6 – HM - (TYPICAL PROCESS BLDG INTERIOR STAIR / EGRESS – SGL DOOR)

3	Hinges	CB199 4 1/2 X 4 1/2	US26D	ST
1	Exit Device (Passage)	3RO 2114 X 4914A S301 SNB (2)	626W	PR
1	Door Closer | Stop	HD8016 S DS SN	689	BE
3	Door Silencers	1229A	GREY	TR

SET #7 – HM - (TYPICAL PROCESS BLDG INTERIOR STAIR / EGRESS – PAIR DOORS)

6	Hinges	CB199 4 1/2 X 4 1/2	US26D	ST
1	Exit Device	3RO 2101 X 4901 S301 SNB (2)	626W	PR
1	Exit Device (Passage)	3RO 2114 X 4914A S301 SNB (2)	626W	PR
1	Rim Cylinder (Mull)	12E-72 PATD R708	626	BE
2	Door Closer | Stop	HD8016 S DS SN	689	BE
2	Door Silencers	1229A	GREY	TR

SET #8 – HM - (TYPICAL OFFICE / PROCESS BLDG INTERIOR EGRESS – SGL DOOR W/CARD READER)

3	Hinges	CB199 4 1/2 X 4 1/2 NRP	US32D	ST
1	Exit Device	3RO 2103 X 4903A S301 SNB (2)	630	PR
1	Rim Cylinder	12E-72 PATD R704	626	BE
1	Electric Strike	0162	630	RC
1	Door Closer	HD8016 SPA SN	689	BE
1	Kick Plate	K0050 - 10" x 2" LDW CSK	630	TR
1	Wall Bumper	1270CX	626	TR
1	Weatherstrip	700 ES (HEAD & JAMBS)		NA
1	Door Sweep	200 NA		NA
1	Saddle Threshold	425 E x SSMS/LA - SIA	AL	NA
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #9 – HM - (TYPICAL OFFICE / PROCESS BLDG INTERIOR MECHANICAL – SGL DOOR)

3	Hinges	CB179 4 1/2 X 4 1/2	US26D	ST
1	Storeroom Lockset	9K3-7D15D PATD S3	626	BE
1	Door Closer	HD8016 SPA SN	689	BE
1	Wall Bumper	1270CX	626	TR
1	Brush Sweep	600 A		NA
1	Gasketing	5040 B (HEAD & JAMBS)		NA

SET #10 - HM - (TYPICAL OFFICE / PROCESS BLDG INTERIOR COMMUNICATION – SGL DOOR W/ CARD READER)

3	Hinges	CB179 4 1/2 X 4 1/2	US26D	ST
1	Storeroom Lockset	9K3-7D15D PATD S3	626	BE
1	Electric Strike	F1114	630	RC
1	Door Closer | HO	HD8016 FH SN	689	BE
1	Wall Bumper	1270CX	626	TR
3	Door Silencers	1229A	GREY	TR
1	Door Contact	1076	D	SE
1	Motion Scanner	915	G	RC
1	Power Supply	BY SECURITY PROVIDER		PR
1	Card Reader	BY SECURITY PROVIDER		BY

SET #11 - WD - (TYPICAL OFFICE / PROCESS BLDG INTERIOR CLOSET – SGL DOOR)

3	Hinges	CB179 4 1/2 X 4 1/2	US26D	ST
1	Classroom Lockset	9K3-7R15D PATD S3	626	BE
1	Overhead Stop	4420 SERIES	US32D	AB
3	Door Silencers	1229A	GREY	TR

SET #12 - HM - (TYPICAL OFFICE BLDG INTERIOR JANITOR – SGL DOOR)

3	Hinges	CB179 4 1/2 X 4 1/2	US26D	ST
1	Storeroom Lockset	9K3-7D15D PATD S3	626	BE
1	Kick Plate	K0050 - 10" x 2" LDW CSK	630	TR
1	Floor Stop	1211	626	TR
3	Door Silencers	1229A	GREY	TR

SET #13 - WD - (TYPICAL OFFICE BLDG INTERIOR MULTI USE RESTROOM – SGL DOOR)

3	Hinges	CB168 4 1/2 X 4 1/2	US26D	ST
1	Pull Plate	1018-3	630	TR
1	Push Plate	1001-9	630	TR
1	Door Closer | HO	HD8016 FH SN	689	BE
1	Kick Plate	K0050 - 10" x 2" LDW CSK	630	TR
1	Wall Bumper	1270CX	626	TR
3	Door Silencers	1229A	GREY	TR

SET #14 - HM - (TYPICAL OFFICE BLDG INTERIOR UNISEX RESTROOM – SGL DOOR)

3	Hinges	CB199 4 1/2 X 4 1/2	US26D	ST
1	Privacy Set	9K3-0L15D S3	626AM	BE
1	Door Closer | HO	HD8016 FH SN	689	BE
1	Wall Bumper	1270CX	626	TR
3	Door Silencers	1229A	GREY	TR

END OF SECTION

SECTION 08 79 13
KEY STORAGE BOXES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for key storage boxes.

1.2 SUBMITTALS

A. Product Data: Include data on access boxes, dimensions, operational features, materials, finishes, and anchorage.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The Knox Company, Model 3200R Knox-Box Rapid Entry System

2.2 COMPONENTS

A. Manufactured Units:

1. Fire department access boxes:
    a. Obtain through the fire department having jurisdiction:
        1) Obtain an order form from an official from the fire department having jurisdiction and submit the order to The Knox Company.
        2) Boxes are shipped without keys and can only be secured by the fire department.
        3) Confirm boxes are in proper working order before installation.
    b. Mounting: Recessed.
    c. Description: Enclosure consisting of 1/4 inch thick plate steel housing, 1/2 inch thick plate steel door with interior gasket seal and SST door hinge. Lock with 1/8-inch SST dust cover.
    d. Lock: Double-action rotating tumblers and hardened steel pins accessed by a biased cut key.
    e. Finish: Powder coat, dark bronze color.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions.

B. Set plumb, level, and rigid.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for glazing.

1.2 REFERENCES
- A. American Architectural Manufacturers Association (AAMA):
  1. 800 – Voluntary Specification and Test Methods for Sealants
- B. American National Standards Institute (ANSI):
  1. Z97.1 – Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test
- C. American Society of Civil Engineers (ASCE):
  1. 7 – Minimum Design Loads for Buildings and Other Structures
- D. ASTM International (ASTM):
  1. C 509 – Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
  2. C 794 – Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
  3. C 864 – Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
  4. C 920 – Standard Specification for Elastomeric Joint Sealants
  5. C 1036 – Standard Specification for Flat Glass
  6. C 1048 – Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
  7. C 1115 – Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories
  8. C 1172 – Standard Specification for Laminated Architectural Flat Glass
  9. C 1281 – Standard Specification for Preformed Tape Sealants for Glazing Applications
  10. E 330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
  11. E 1300 – Standard Practice for Determining Load Resistance of Glass in Buildings
  12. E 2190 – Standard Specification for Insulating Glass Unit Performance and Evaluation
- E. Insulating Glass Manufacturers Alliance (IGMA):
  1. TM-3000 – Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use
- F. National Fenestration Rating Council (NFRC):
  1. 100 – Procedure for Determining Fenestration Product U-factors
  2. 200 – Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
  3. 300 – Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems
- G. National Fire Protection Association (NFPA):
  1. 252 – Standard Methods of Fire Tests of Door Assemblies
- H. National Glass Association with GANA (NGA):
  1. Glazing Manual
  2. Laminated Reference Glazing Manual
- I. U.S. Consumers Product Safety Commission (CPSC):
  1. 16 CFR 1201 – Safety Standard for Architectural Glazing Materials

1.3 SUBMITTALS
- A. Product Data: Descriptive data and performance attributes for each product and glazing material.
- B. Samples for each glass product other than clear monolithic vision glass.
  1. Glass samples: 12 inches by 12 inches.
  2. Structural sealant samples showing available colors: 1/4 inch by 1/4 inch by 3 inches long.
- C. Quality Control Submittals:
  1. Test report: A pre-construction adhesion and compatibility test report from the Glazing Sealant Manufacturer based on submitted samples or acceptable data from previous testing of current formulations with similar products.
  2. Test report: Evaluation of comprehensive tests by a qualified testing agency for insulating glass.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
  3. Installers certified under the NGA's certified glass installer program.
- B. Regulatory Requirements: Provide tempered or laminated safety glass for locations subject to human impact as required by the building code.
- C. Perform Work in accordance with the NGA Glazing Manual, NGA Laminated Glazing Reference Manual, and the IGMA TM-3000.
- D. Glazing Labels: Provide glass lites bearing the Manufacturer's label showing the strength, grade, thickness, type, and quality. Retained labels shall remain on the glass until it has been set and inspected. Submit an affidavit for glass furnished unlabeled from the local stock stating the required information.
- E. Single Source Responsibility: Provide materials composed of primary glass produced by a single Manufacturer or fabricator for each kind and condition of glass shown on the Drawings.

F. Safety Glazing Products: In accordance with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.
   1. Obtain safety glazing products permanently marked with the certification label of the Safety Glazing Certification Council or another certification agency acceptable to the AHJs.
   2. Where glazing units, including Kind FT glass and laminated glass, are specified in this Section for glazing lites more than 9 sf in area, provide glazing products that comply with Category II materials, and for lites 9 sf or less in area, provide glazing products that comply with Category I or II materials.

G. Fire Protection Rated Glazing Labeling: Permanently mark fire protection rated glazing with the certification label of a testing agency acceptable to the AHJs. The label shall indicate the Manufacturer's name, test standard, if glazing is for use in fire doors or other openings, if glazing passes hose stream test, if glazing has a temperature rise of 450°F, and the fire resistance rating is minutes.

H. Insulating Glass Certification Program: Permanently marked either on spacers or on at least one component lite of the units with the appropriate certification label of IGCC.

I. Performance Requirements:
   1. Glass thicknesses:
      a. Thicknesses shown on the Drawings are minimums; select actual glass thicknesses by analyzing loads and conditions.
      b. Minimum glass thickness, nominally, of lites in exterior walls is 0.23 inch (6.0 mm).
      c. Size glass to withstand positive and negative wind pressure acting normal to plane in accordance with ASCE 7 as measured in accordance with ASTM E 330.
      d. Provide glass in thicknesses and strengths to meet or exceed the following criteria:
         1) In accordance with ASTM E 1300.
         2) Probability of breakage for vertical glazing: Eight lites per 1,000 for lites set within 15 degrees of vertical and under wind load for load duration of 3 seconds.
         3) Probability of breakage for sloped glazing: One lite per 1,000 for lites set more than 15 degrees off vertical and under wind load and snow load for a duration of 30 days.
         4) Thickness of tinted glass: Provide same thickness for each tint color for all applications.
   2. Thermal and optical performance properties: Provide glass meeting specified performance properties based on the Manufacturer's published test data for units of thickness as shown on the Drawings:
      a. U-factor: In accordance with NFRC 100 expressed as Btu/hr-ft2-°F.
      b. Solar heat gain coefficient: In accordance with NFRC 200.
      c. Solar optical properties: In accordance with NFRC 300.
   3. Normal thermal movement: Provide glazing to withstand an ambient temperature range of 120°F and a surface temperature range of 180°F.

1.5 SITE CONDITIONS

A. Perform glazing when ambient temperature is above 40°F.

B. Perform glazing on dry surfaces.

1.6 WARRANTY

A. Manufacturer:
   1. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the insulating glass unit system and associated appurtenances, including obstruction of vision through the unit due to:
      a. The intrusion of dust or moisture.
      b. Internal condensation.
      c. Film formation on internal glass surfaces caused by a failure of the hermetic seal, except failure caused in whole or in part by the breakage or fracturing of any portion of the glass surface.
   2. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the glass coating system and associated appurtenances, including peeling, cracking, or deterioration of the coating under normal conditions.
   3. Warranty for 10 years from the Substantial Completion date for the satisfactory performance and installation of the laminated glass system and associated appurtenances, including edge separation or delamination materially obstructing vision through glass, and blemishes exceeding those allowed by ASTM C 1172, under normal conditions.
   4. Warranty for 15 years from the Substantial Completion date for the satisfactory performance and installation of the mirror glass system and associated appurtenances, including silver spoilage.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Float Glass:
   1. AFG Industries
   2. Guardian Industries Corporation
   3. PPG Industries, Inc.
   4. Pilkington North America

B. Heat-Treated Float Glass:
   1. AFG Industries
   2. Cardinal Glass Industries
   3. Pilkington North America
   4. PPG Industries

C. Insulating Glass:
   1. J.E. Berkowitz
   2. Oldcastle Building Envelope
   3. Viracon
D. Fire Protection Rated Glazing:
   1. Nippon Electric Glass Co., Ltd.,
   2. Schott North America, Inc.
   3. Vetrotech Saint-Gobain

2.2 MATERIALS

A. Float Glass: In accordance with ASTM C 1036, Type I transparent flat, Class 1 clear, Quality Q3 glazing select.
B. Clear Heat-Treated Glass: In accordance with ASTM C 1048, transparent flat, Quality Q3 glazing select, Kind FT fully tempered or Kind HS heat strengthened, for conditions specified.
C. Uncoated Tinted Glass: In accordance with ASTM C 1048, Type I transparent flat, Class 2 tinted heat absorbing and light reducing, Quality Q3 glazing select, Kind FT fully tempered, or Kind HS heat strengthened.
D. Laminated Glass:
   1. Heat strengthened glass laminated in an autoclave under heat and pressure to a clear interlayer, in accordance with ASTM C 1172.
   2. Interlayer: Polyvinyl butyral.
   3. Laminated safety glass: In accordance with ANSI Z97.1 and CPSC 16 CFR 1201.
E. Insulating Glass:
   1. Insulating glass units: Factory assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E 2190, and complying with other requirements specified.
      a. Sealing system: Dual seal, with the Manufacturer's standard polyisobutylene and silicone primary and secondary.
      b. Spacer: Manufacturer's standard aluminum spacer material and construction.
      c. Desiccant: Molecular sieve or silica gel, or blend of both.
   2. Glass: Comply with applicable requirements in this Section.
F. Mirror Glass:
   1. In accordance with ASTM C 1036 float glass Type 1 transparent flat, Class 1 clear, mirror quality.
   2. Coating: Silver coating and protective electrolytic copper coating not less than 0.0002 inch.
   3. Backing: Two coats of special mirror backing paint totaling 2 mils DFT.
G. Fire Protection Rated Glazing:
   1. Listed and labeled for fire protection rating, in accordance with NFPA 252 for door assemblies.
   2. Clear, flat sheets of monolithic ceramic glazing material.
   3. Laminated ceramic glazing: Two plies of ceramic flat glass, 5/16 inch total nominal thickness, in accordance with 16 CFR 1201 for Category II materials.

2.3 ACCESSORIES

A. General: Provide accessories complying with the following requirements:
   1. Compatibility: Provide materials and products of proven compatibility with other materials with which they will come into contact.
   2. Suitability: Comply with the recommendations of the accessory and Glass Manufacturers for the selection of materials and products that have performance characteristics suitable for applications shown on the Drawings and conditions at the time of installation.
B. Setting Blocks: In accordance with ASTM C 864, neoprene or EPDM, or ASTM C 1115, silicone; 80 to 90 Shore A durometer hardness.
C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by the Glass Manufacturer to maintain glass lites in place.
D. Glazing Gaskets:
   1. Dense compression gaskets: In accordance with ASTM C 864, neoprene or EPDM, or ASTM C 1115, silicone or thermoplastic polyolefin rubber, molded or extruded shape to fit the glazing channel retaining slot; black color.
   2. Soft compression gaskets: In accordance with ASTM C 509, Type II, black, molded or extruded, neoprene, EPDM, silicone or thermoplastic polyolefin rubber, of the profile and hardness required to maintain a watertight seal; black color.
E. Glazing Sealant:
   1. Suitability: Comply with the recommendations of the Sealant and Glass Manufacturers that have performance characteristics suitable for project applications.
   2. Elastomeric sealant standard: Provide the Manufacturer's standard chemically curing sealant in accordance with ASTM C 920.
   3. Color: To be selected from the Manufacturer's full color range.
F. Primer: As recommended by the Glazing Sealant Manufacturer.
G. Glazing Tape: Butyl based elastomeric tape with integral resilient tube spacer, 10 to 15 Shore A durometer hardness, black color, coiled on release paper; widths required for installation, in accordance with ASTM C 1281 and AAMA 800.
H. Glazing Tape: Closed-cell PVC foam, maximum 2% water absorption by volume, designed for 25% compression for air barrier and vapor retarder seal, black color, coiled on release paper over adhesive on two sides; widths required for installation, in accordance with AAMA 800.

2.4 FABRICATION

A. Heat Strengthened or Tempered Glass:
   1. In accordance with ASTM C 1048.
   2. Process in a horizontal position so that inherent roller distortion will run parallel to building floor lines after installation.

B. Sealed Insulating Glass:
   1. In accordance with ASTM E 2190.
   2. Fabricate spacer bar frame of tubular aluminum filled with desiccant.
   3. Bond spacer bar frame to glass panes with twin primary seals.
   4. Fill space outside frame to glass edge with elastomeric sealant.
   5. Safety glass: At locations where safety glazing is required, provide heat strengthened or tempered glass at both panes.

C. Low-E Coated Glass: Apply low-emissivity coating to scheduled glass surface.

D. Fabrication Tolerances: In accordance with ASTM C 1036 and ASTM C 1048.

E. Glass Identification:
   1. Apply the Manufacturer's label indicating the type and thickness to each lite of glass. Show the position of exterior face when installed, where applicable.
   2. Etch the Manufacturer's label on each lite of tempered glass.

F. Source Quality Control:
   1. Pre-construction adhesion and compatibility testing:
      a. Perform an adhesion test including UV exposure through glass on production samples of metals and glass in accordance with ASTM C 794.
      b. Test glass units, glazing materials, and glass framing members with specified finish for sealant compatibility, priming, and preparation requirements for optimum adhesion and performance.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean glazing rabbets; remove loose and foreign matter.

B. Remove protective coatings on metal surfaces.

C. Clean glass just prior to installation.

3.2 INSTALLATION

A. General:
   1. Install glass in accordance with the Glass Manufacturer's instructions.
   2. Maintain the Manufacturer's recommended edge and face clearances between glass and frame members.

B. Structural Silicone Glazing Method:
   1. Mask aluminum and glass surfaces adjacent to sealant pockets.
   2. Install temporary glass retainers to align faces of glass.
   3. Apply contact sealant; completely fill pockets. Tool joints and remove masking tape before the sealant skim cure begins.
   4. Allow the sealant to cure for the minimum time required by the Manufacturer.
   5. Remove temporary glass retainers.
   6. Insert joint backing to fill the void between glass unit edges and glass spacer.
   7. Mask both sides of glass for the full length of the joint.
   8. Apply weatherseal sealant; tool to a smooth, slightly concave profile.

C. Silicone Glazing Method:
   1. Mask both sides of the joint for full length.
   2. Install temporary glass retainers to align faces of glass.
   3. Provide temporary joint backing for one side of the joint.
   4. Apply sealant to completely fill spaces and tool to a smooth, slightly concave surface.
   5. Allow the sealant to cure for the minimum time required by the Manufacturer. Remove temporary backing and fill voids with additional sealant.

D. Gasket Glazing Method:
   1. Fabricate gaskets to fit openings; allow for the stretching of gaskets during installation.
   2. Set the soft compression gasket against fixed stop or frame with bonded miter cut joints at corners.
   3. Set glass centered in openings on setting blocks.
   4. Install removable stops and insert dense compression gaskets at corners, working toward the center of glass, compressing glass against soft compression gaskets to produce a weathertight seal.
   5. Seal joints in gaskets.
   6. Allow gaskets to protrude past the face of glazing stops.

E. Sealant Glazing Method:
   1. Apply sealant to the full depth of permanent stops.
   2. Press glass into sealant with a slight lateral movement to ensure adhesion.
   3. Apply sealant to the full depth of removable stops. Secure stops in position, forcing contact with sealant bead and completely filling the joint.

F. Sealant and Tape Glazing Method:
   1. Apply tape to permanent stops, projecting slightly above sight line.
   2. Press glass into contact with tape.
   3. Install removable stops with spacer shims between the stop and the glass.

4. Fill the gap between the removable stop and glass with glazing sealant.
5. Trim protruding tape edges.

G. Tape Glazing Method:
1. Apply tape to permanent stops projecting slightly above the sight line.
2. Press glass into contact with tape.
3. Place glazing tape on the removable stop side of glass.
4. Install the removable stop and apply pressure to ensure contact.
5. Trim protruding tape edges.

3.3 PROTECTION

A. After installation, mark glass with an X using removable plastic tape.

3.4 CLEANING

A. Perform final cleaning within 5 days prior to the Substantial Completion date.

END OF SECTION

INTENTIONALLY BLANK

SECTION 08 87 00
GLAZING SURFACE FILMS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for glazing surface films.

1.2 REFERENCES
- A. American National Standards institute (ANSI):
  1. Z97.1 – Safety Glazing Materials Used in Buildings
- B. ASTM International (ASTM):
  1. C 1184 – Standard Specification for Structural Silicone Sealants
  2. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- C. Underwriters Laboratories (UL):
  1. 752 – Standard for Bullet-Resisting Equipment
- D. Underwriters Laboratories of Canada (CAN/ULC):
  1. S332 – Standard for Burglary Resisting Glazing Material
- E. U.S. Consumer Product Safety Commission (CPSC):
  1. 16 CFR 1201 – Safety Standard for Architectural Glazing Materials
- F. U.S. General Services Administration (GSA):
  1. TS01 –Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings

1.3 SUBMITTALS
- A. Product Data: Manufacturer's data sheets on each product to be used including:
  1. A record of product certification for safety requirements.
  2. Preparation instructions and recommendations.
  3. Installation methods.
- B. Shop Drawings: Detailing the installation of film, anchoring accessories, and sealant.
- C. Samples: Provide two samples for each product specified that are 4 inches by 6 inches at a minimum and represent the actual product in color and pattern.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 10 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Comply with safety requirements.
- D. Burglar Resistance Specification: In accordance with CAN/UL S332.
- E. Blast Resistance Specification: Provide Level 3A blast resistance when tested in accordance with GSA TS01 at a peak pressure of 4 psi and a positive phase impulse of 28 psi/msec; impact resistance in accordance with ANSI Z97.1 and CPSC 16 CFR 1201 Category II using SL-14.
- F. Bullet Resistance Specification: Provide bullet resistance when tested in accordance with UL 752 using minimum 12 mm thick annealed glass, and impact resistance in accordance with ANSI Z97.1 and CPSC 16 CFR 1201, Category II using SL-14.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store products in the Manufacturer's unopened packaging until ready for installation.

1.6 SITE CONDITIONS
- A. Maintain environmental conditions (temperature, humidity, and ventilation) within the limits recommended by the Manufacturer for optimum results. Do not install products under environmental conditions outside the Manufacturer's absolute limits.

1.7 WARRANTY
- A. Manufacturer: Provide a lifetime warranty from the Substantial Completion date for the satisfactory performance and installation of the glazing surface film system and associated appurtenances, including a replacement warranty to cover films against peeling, cracking, yellowing, delamination, or demetallization.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Advanced Coating Engineering LLC, ACE Security Laminates

2.2 MATERIALS
- A. General: The representative surface glazing film specified below is ACE Security Laminates 300 Series SL-14. This product is required for glazing requiring surface glazing films. A glass thickness of 1/2 inch is required.
- B. Glazing Surface Film: ACE Security Laminates transparent polyester, micro-thin laminate; when bonded to 12 mm annealed glass, it converts the glazing in accordance with UL 752 Level II bullet-resistant glazing:
  1. Thickness: 0.014 inch, SL-14.
  2. Color: Clear.
  3. Construction: Multi-ply laminate.
  4. Adhesive type: Pressure-sensitive acrylic.
  5. Tensile strength: 28,000 psi.
  6. Breaking strength: 350 lbs/in width.

7. Burn characteristics: A flame spread average index of 5 and a smoke developed average index of 10 when tested in accordance with ASTM E 84, Class A.
8. UV radiation rejection: 98%.

2.3 ACCESSORIES

A. Accessory Materials: As recommended or required by the Film Manufacturer.
B. Structural Silicone Sealant: Self-priming, elastomeric adhesive in accordance with ASTM C 1184.
C. Glass Cleaner: As recommended by the Glazing Film Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that existing conditions are adequate for the proper application and performance of the film.
B. Examine glass and frames. Verify that existing conditions are adequate for the proper application and performance of the film.
C. Verify glass is not cracked, chipped, broken, or damaged.
D. Verify frames are securely anchored and free of defects.
E. If substrate preparation is the responsibility of another installer, notify the ENGINEER of unsatisfactory preparation before proceeding.
F. Clean glass of dust, dirt, paint, oil, grease, mildew, mold, and other contaminants that may inhibit adhesion.
G. Immediately prior to applying the film, thoroughly wash glass with a neutral cleaning solution.
H. Protect adjacent surfaces.

3.2 INSTALLATION

A. Factory or shop-install the film to the glazing prior to installation in the frames.
B. Glazing Film:
1. Do not apply glazing film when the surface temperature is below 40°F.
2. Do not begin installation until substrates are properly prepared.
3. Application: Install in accordance with the Manufacturer's instructions, without air bubbles, wrinkles, streaks, bands, thin spots, pinholes, or gaps.
a. Accurately cut film with straight edges to the required sizes allowing 1/16 inch to 1/8 inch gap at the perimeter of the glazed panel.
b. Remove the release liner immediately prior to adhering the film to the glass.
c. Seams:
1) Seam film as required to accommodate material sizes.
2) Form seams vertically without overlaps and gaps.
3) Do not install with horizontal seams unless necessary.
C. Glass: Install in accordance with the Manufacturer's installation recommendations.
D. Anchoring: Install behind glazing stops.
1. Structural Silicone Sealant: Apply in accordance with the Manufacturer's instructions and the approved Shop Drawings.
a. Install structural silicone sealant for achieving blast resistance in accordance with GSA TS01, Level 3A.
b. Coordinate with the installation of glass and the application of the glazing film to ensure compatibility, proper recesses, and backing are provided for the sealant.
c. Apply sealant to glazing recesses without voids.
d. Install with sealant bridges glazing film and frame.
e. Ensure a complete bond of the sealant to the glass and the frame.

3.3 PROTECTION

A. Protect installed products until the Final Completion date.
B. Touch up, repair, or replace damaged products prior to the Substantial Completion date.

3.4 QUALITY CONTROL

A. Verify installation is complete and complies with the requirements and the Manufacturer's instructions to the specified blast resistance level, correcting deficiencies if any exist.

3.5 CLEANING

A. Clean glass and anchoring accessories following installation. Remove excess sealants and other glazing materials from adjacent finished surfaces.
B. Remove labels and protective covers.
C. Perform final cleaning within 5 days prior to the Substantial Completion date.
D. Remove and legally dispose of debris and excess material resulting from the Work.

END OF SECTION

SECTION 08 91 00
LOUVERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for louvers.

B. Related Sections:

1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
3. SECTION 01 40 00 – QUALITY REQUIREMENTS
4. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
5. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
6. SECTION 01 91 00 (.01 or .02) – COMMISSIONING
7. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES

A. Air Movement and Control Association Inc. (AMCA):

1. 500-L – Laboratory Methods of Testing Louvers for Rating
2. 501 – Louver Application Manual and Design Guide

B. American Architectural Manufacturers Association (AAMA):

1. 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

C. American Welding Society (AWS):

1. D1.2 – Structural Welding Code – Aluminum

D. ASTM International (ASTM):

1. B 26 – Standard Specification for Aluminum-Alloy Sand Castings
2. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
3. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
4. D 1187 – Type II – Specification for Asphalt-Base Emulsions (For Metal Surfaces)
5. E 488 – Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

E. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products

F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. 1793 – Architectural Sheet Metal Manual

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to the bottom of the unit and away from the opening.

D. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing in accordance with AMCA 500-L.

1.4 SUBMITTALS

A. Submit the following:

1. Product data: For each type of product indicated.
   a. For louvers specified to bear AMCA seal, include printed catalog catalogue pages showing specified models with appropriate AMCA certified ratings seals.
2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show frame profiles and blade profiles, angles, and spacing.
   a. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
   b. Show mullion profiles and locations.
3. Samples color selection: Color selector showing the full range of the Manufacturer’s standard colors.
4. Samples for verification: Two samples of each color requested by the ENGINEER for selection.
5. Delegated design submittal: For louvers to comply with structural performance requirements and design criteria specified in this Section, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
6. Product test reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by the Manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with the performance requirements specified in this Section.

B. O&M Special Requirements:

1. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).

1.5 QUALITY ASSURANCE

A. Performance Requirements:

1. Delegated design: Design louvers, including comprehensive engineering analysis by a qualified Professional Engineer, using structural the performance requirements and design criteria indicated.
2. Structural performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under the conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

B. Wind Loads: Determine loads based on pressures as shown on the Drawings.
C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
1. Temperature change (range): 120°F, ambient; 180°F, material surfaces.
D. Louver Performance Ratings: Provide louvers in accordance with requirements specified, as demonstrated by testing the Manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
E. Comply with the requirements specified in SECTION 01 40 00.
F. Source Limitations: Obtain louvers and vents from a single source from a single Manufacturer where indicated to be of the same type, design, or factory-applied color finish.
G. Welding: Qualify procedures and personnel in accordance with AWS D1.2.
H. SMACNA Standard: Comply with recommendations in SMACNA 1793 for fabrication, construction details, and installation procedures.

1.6 DELIVERY, STORAGE, AND HANDLING
A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
1. Brace and support units to prevent deformation during delivery.
2. Factory wrap units with accepted materials to protect finish during delivery and storage.
3. Handle units with care to prevent bending or scratching.
4. Placement:
a. Material shall be placed in accordance with sound material handling practices and in such a way as to minimize racking.
b. Louver sections may be hoisted by attaching straps to the jambs and lifting the section while it is in a vertical position.
c. Louver sections shall only be lifted and carried by the jambs. Heads, sills and blades are not to be used for lifting or hoisting louver sections.
5. Shop assembly for architectural screen: Coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments, mechanical attachment, and field assembly of units. Pre-assemble units in shipments to the greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

1.7 SITE CONDITIONS
A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Fixed, Extruded-Aluminum Louvers:
1. Horizontal, drainable-blade louver:
a. Construction Specialties, Inc., A4097
b. Greenheck Fan Corporation, ESD-403
c. Nystrom Building Products, Drainable Louvers, LSA4D45
d. Ruskin Company; Tomkins PLC, ELF 375 Series

2.2 MATERIALS
A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by the metal producer for the required finish.
C. Aluminum Castings: ASTM B 26, Alloy 319.
D. Security Bars:
1. Vertical bars: 1/2 inch minimum diameter zinc-plated steel bar. Rockwell hardness of 80/90B.
2. Horizontal bars: 2 inch x 1/4 inch flat bar.
3. Grille frame: 10 gauge x 2 inch galvanized steel.

2.3 COMPONENTS
A. Fixed, Extruded-Aluminum Louvers:
1. Horizontal, drainable-blade louver:
a. Louver depth: 4 inches.
b. Frame and blade nominal thickness: Not less than 0.080 inch for blades and 0.080 inch for frames.
c. Mullion type: Sliding interlock with internal drains.
d. Heads, sills, jambs and mullions to be one-piece structural aluminum members with integral caulking slot and retaining beads.
e. Blades to be one-piece aluminum extrusions with gutter(s) designed to catch and direct water to jamb and mullion drains.
f. Louver performance ratings:
1) Free area: Not less than 8.0 sf for 48 inch wide by 48 inch high louver.
2) Free area velocity at point of beginning water penetration: Not less than 1040 fpm.
3) Intake pressure drop at point of beginning water penetration: Not more than 0.20 inch water gauge static pressure drop.
4) Air performance: Not more than 0.18 inch water gauge static pressure drop at 1000 fpm free-area exhaust velocity.
5) AMCA seal: Mark units with the AMCA certified ratings seal.

B. Louver Screens:
1. General: Provide a screen at each exterior louver.
a. Screen location for fixed louvers: Interior face.
b. Screening type: Bird screening.
2. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches on center.
3. Louver screen frames: Fabricate with mitered corners to the louver indicated.
a. Metal: The same kind and form of metal as indicated for the louver which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
b. Finish: The same as louver to which the louver screens are attached.
c. Type: Re-wirable frames with a driven spline or insert.
4. Louverscreening for aluminum louvers:
a. Bird screening: Aluminum, 1/2 inch square mesh, 0.063-inch wire.
b. Blank-off panels:
1) Insulated, blank-off panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to the back of the louver.
a) Thickness: 2 inches.
b) Metal facing sheets: Aluminum sheet, not less than 0.032 inch nominal thickness.
c) Insulating core: Extruded-polystyrene foam.
d) Edge treatment: Trim perimeter edges of blank-off panels with the Louver Manufacturer's standard extruded-aluminum-channel frames, not less than 0.080 inch nominal thickness channel frames, with corners mitered and with the same finish as panels.
e) Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
f) Panel finish: The same type applied to the louver.
g) Attach blank-off panels with clips.

2.4 ACCESSORIES
A. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series SST fasteners.
3. For color-finished louvers, use fasteners with heads that match the color of the louvers.
B. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from SST components, with capability to sustain, without failure, a load equal to four times the loads imposed, for concrete, or six times the load imposed, for masonry, as determined by testing in accordance with ASTM E 488, conducted by a qualified independent testing agency.
C. Jamb Trim: Provide jamb trim at louvers where stone facing returns to the louver frames as shown on the Drawings. Jamb trim shall be fabricated from material matching the louver construction and finished to match.
D. Bituminous Paint: Cold-applied asphalt emulsion in accordance with ASTM D 1187.
E. Security Bars:
1. Vertical and horizontal bars of materials specified within this Section and on-center spacing as indicated. Vertical bars shall pass through the horizontal bars. Bars shall be welded to the frame and at each intersection of the horizontal bar.
a. Vertical bar spacing: 6 inches on center.
b. Horizontal bar spacing: 12 inches on center.

2.5 FABRICATION
A. Assemble louvers in the factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
B. Vertical Assemblies: Where the height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
1. Horizontal mullions: Provide horizontal mullions at joints where shown on the Drawings or required due to the height of the louver.
C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
D. Include supports, anchorages, and accessories required for complete assembly.
E. Heads, sills, jambs and mullions shall be one-piece structural aluminum members with integral caulking slot and retaining beads.
F. Blades shall be one-piece aluminum extrusions with gutter(s) designed to catch and direct water to jamb and mullion drains.
1. Provide vertical mullions of sliding interlock type and at spacings indicated, but not more than recommended by the Manufacturer, or 72 inches on center, whichever is less.
2. Exposed mullions: Where indicated, provide units with exposed mullions of the same width and depth as the louver frame. Where the length of the louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
G. Provide sub-sills made of the same material as the louvers or extended sills for recessed louvers as shown on the Drawings.
H. Join frame members to each other and to fixed louver blades mechanically with SST or aluminum fasteners. Match the louver color where exposed to view.

2.6 FINISHES

A. Provide finishes in accordance with NAAMM Metal Finishes Manual for Architectural and Metal Products for recommendations for applying and designating finishes.

B. Aluminum Finishes:

1. Apply finishes in the factory.
2. High-performance organic finish: Two-coat fluoropolymer finish in accordance with AAMA 2605 and containing not less than 70% PVDF resin by weight in the color coat. Prepare, pretreat, and apply coating to exposed metal surfaces in accordance with the Coating and Resin Manufacturer's instructions.
   a. Color and gloss: As selected by the ENGINEER from the Manufacturer's full range as specified in SECTION 01 33 00.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine substrates and openings, with the Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Coordinate setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to Project site.

3.2 INSTALLATION

A. Locate and place louvers and vents level, plumb, and in alignment as specified in this Section with adjacent Work.

B. Use concealed anchorages where possible. Use non-ferrous metal or hot-dip galvanized anchors and inserts for installation and elsewhere as required for corrosion resistance. Use SST or lead expansion bolt devices for drilled-in place anchors. Furnish inserts, as required, to be set into concrete or masonry Work.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective Work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire units or provide new units.

G. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

H. Install security bars, concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Seal joints between units and substrate to provide a weathertight installation at all joints and intersections and at opening perimeters. Comply with requirements as specified in SECTION 07 92 00 for sealants applied during louver installation.

I. Erection Tolerances:

1. Maximum variation from plane or location shown on the approved Shop Drawings: 1/8 inch per 12 feet of length, but not exceeding 1/2 inch in any total building length or portion thereof (non-cumulative).
2. Maximum offset from true alignment between two members abutting end to end, edge-to-edge in line or separated by less than 3 inch: 1/16 inch (shop or field joints). This limiting condition shall prevail under both load and no load conditions.

3.3 PROTECTION

A. Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, louver units will be free of damage or deterioration at the time of final inspection.

3.4 STARTUP

A. Startup and commissioning requirements for the equipment specified herein as specified in SECTION 01 91 00.

3.5 CLEANING

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering to remove fingerprints and soil during the construction period. Do not let soil accumulate during the construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective Work. If results of the restoration are unsuccessful, as determined by ENGINEER, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches the color and gloss of, and is compatible with, the factory-applied finish coating.

END OF SECTION

SECTION 09 29 00
GYPSUM BOARD

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for gypsum board.

1.2 REFERENCES
- A. American National Standards Institute (ANSI):
  1. A118.9 – Test Methods and Specifications for Cementitious Backer Units
- B. ASTM International (ASTM):
  1. A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  2. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  3. C 475 – Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
  4. C 645 – Standard Specification for Nonstructural Steel Framing Members
  5. C 665 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
  6. C 754 – Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
  7. C 834 – Standard Specification for Latex Sealants
  8. C 954 – Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
  9. C 1002 – Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
  10. C 1047 – Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
  11. C 1396 – Standard Specification for Gypsum Board
  12. D 3273 – Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
  13. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  14. E 90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
  15. E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials
  16. E 136 – Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C
  17. E 413 – Classification for Rating Sound Insulation
- C. Gypsum Association (GA):
  1. 214 – Recommended Levels of Finish for Gypsum Board, Glass Mat and Fiber-Reinforced Gypsum Panels
  2. 216 – Application and Finishing of Gypsum Panel Products
  3. 600 – Fire Resistance and Sound Control Design Manual
- D. Underwriters Laboratories, Inc. (UL):
  1. Fire Resistance Directory

1.3 SUBMITTALS
- A. Product Data:
  1. Metal stud framing: Illustrate framing types, gauges, and locations.
  2. Gypsum board: Illustrate panel product types, thicknesses, and locations, acoustical insulation, and accessories.
  3. Accessories: Data for each specified product.
- B. Quality Control Submittal:
  1. Fire-test-response reports: From a qualified independent testing agency substantiating each gypsum board shaftwall assembly's required fire resistance rating.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. General: Perform Work in accordance with the following:
  1. Steel framing: In accordance with ASTM C 754.
  2. Gypsum board finish: In accordance with GA 214 and GA 216.
  3. Local building code requirements.
- B. Fire Resistance Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E 119 by an independent testing agency.
  1. Construct assemblies in accordance with GA 600 and the UL Fire Resistance Directory.
- C. STC Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E 90 and classified in accordance with ASTM E 413 by and independent testing agency.
- D. Deflection Limits:
  1. Limit the deflection of partitions to the following limits, based on a 5 psf uniform design load:
     a. Partitions to receive tile: 1/360 of the span.
     b. Other partitions: 1/120 of the span.
  2. If the partition height exceeds the Stud Manufacturer's limiting height for applicable loading and deflection, install bracing above the ceiling, decrease stud spacing, or increase stud gauge.

1.5 SITE CONDITIONS
- A. Do not install gypsum board until the building is substantially weathertight.
- B. Maintain a temperature between 55°F and 70°F in the space to receive gypsum board for 2 days before and 3 days after installation; subsequently maintain a 55°F minimum temperature.
- C. Ventilation: Provide ventilation by the use of fans or the building's HVAC system.
- D. Lighting: Maintain lighting at a minimum uniform level of 50 foot-candles where finish work is occurring.

1.6 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the gypsum board system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Metal Framing:
  1. Cemco
  2. Clark Dietrich Building Systems
  3. Marino Ware, Division of Ware Industries
  4. Scafco Steel Stud Company
- B. Gypsum Boards, Shaftwall Boards:
  1. Eagle Materials Inc., American Gypsum
  2. Domtar Gypsum
  3. Georgia Pacific Gypsum
  4. National Gypsum Company, Gold Building Products Division
  5. United States Gypsum Company

2.2 MATERIALS
- A. Metal Framing:
  1. Steel sheet components in accordance with ASTM C 645.
  2. Steel: In accordance with ASTM A 653, Structural Quality, Class G40 hot-dip galvanized.
  3. Studs: Non-load bearing rolled steel; provide with flange edges bent back 90 degrees and doubled over to form a 3/16 inch minimum lip (return), punched for utility access.
     a. Depth: 3 5/8 inches; 1 5/8 inches or 2 1/2 inches or 6 inches or 8 inches where shown on the Drawings.
     b. Minimum base metal thickness and yield stress: 0.0155 inch/50 ksi.
     c. At door jambs and walls having a tile finish provide minimum base metal thickness and yield strength: 0.0312 inch/33 ksi.
  4. Top and bottom runners:
     a. The same material and finish as the studs, channel shaped.
     b. Deflection compensating top runners, where deflection of the overhead structure is anticipated: Deep leg runners of thickness and flange depth required to accommodate vertical movement and height of wall required.
  5. For ceiling framing suspended from channels:
     a. Suspended ceiling or soffit framing:
        1) Cold rolled channels: 1 1/2 inches deep, cold-rolled, channel shaped, 16 gauge core steel.
        2) Furring channels: Hat shaped, 7/8 inch deep, 25 gauge, cold-rolled core steel.
     b. Steel backing plate: Blocking and bracing, in accordance with ASTM A 653; 6 inches deep, 16 gauge, cold-rolled core steel.
     c. Shaftwall framing: Manufacturer's standard C-H and I-shaped studs and J-shaped runners, hot-dipped galvanized steel, as recommended for the required rating.
        1) Depth: 2 1/2 inches and 4 inches where shown on the Drawings.
        2) Thickness: 25 or 20 gauge where shown on the Drawings.
- B. Gypsum Boards:
  1. Regular gypsum board: 48 inches wide by 5/8 inch thick, maximum practicable length, tapered edge; in accordance with ASTM C 1396.
  2. Fire-resistant gypsum board: 48 inches wide by 5/8 inch thick, maximum practicable length, tapered edge; apply to fire rated assemblies; in accordance with ASTM C 1396, Type X.
  3. Mold and moisture resistant gypsum board: 48 inches wide by 5/8 inch thick, maximum practicable length, water-resistant; apply to walls as shown on the Drawings; in accordance with ASTM C 1396.
     a. Mold resistance: In accordance with ASTM D 3273, score of 10.
  4. Shaftwall boards:
     a. Liner board: 1 inch thick by 24 inches wide, beveled edge, as required for the specified rating.
     b. Face board: 48 inches wide by 5/8 inch thick, maximum practicable length, tapered edge, as required for the specified rating, in accordance with ASTM C 1396, Type X.
     c. Fire resistance: Non-combustible core in accordance with ASTM E 136. Flame spread 15 and smoke developed 0 tested in accordance with ASTM E 84.
- C. Cementitious Backer Units: High density, cementitious with glass fiber reinforcing, nominally 5/8 inch thick by 36 inches wide, maximum practicable length, ends and edges square cut in accordance with ANSI A118.9; apply where shown on the Drawings,

2.3 ACCESSORIES

A. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
   1. Use screws in accordance with ASTM C 954 for fastening panels to steel members from 0.033 inch to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by the Panel Manufacturer.

B. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

C. Acoustical Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant in accordance with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies in accordance with ASTM E 90.

D. Interior Trim: Provide in accordance with ASTM C 1047.
   1. Material: Galvanized or aluminum coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. LC-bead: J-shaped; exposed long flange receives joint compound.
      c. L-bead: L-shaped; exposed long flange receives joint compound.
      d. J-bead: J-shaped; exposed short flange receives joint compound.
      e. Expansion (control) joint.

E. Joint Treatment Materials: Provide in accordance with ASTM C 475.
   1. Joint tape: As recommended by the Panel Manufacturer.
   2. Joint compound for interior gypsum board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
      a. Prefiling: At open joints or beveled panel edges, and damaged surface areas, use setting-type taping compound.
      b. Embedding and first coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
         1) Use setting-type compound for installing paper-faced metal trim accessories.
      c. Fill coat: For second coat, use setting-type, sand able topping compound.
      d. Finish coat: For third coat, use drying-type, all-purpose compound.
      e. Skim coat: For final coat of Level 5 finish, use drying type, all-purpose compound.
   3. Joint compound for tile backing panels:
      a. Cementitious backer units: As recommended by the Cementitious Backer Unit Manufacturer.

F. Wire: Galvanized steel, in accordance with ASTM A 641.
   1. Hanger wire: 8 gauge.
   2. Tie wire: 18 gauge, soft annealed.

PART 3 EXECUTION

3.1 INSTALLATION

A. Partition Framing:
   1. Install in accordance with ASTM C 754 and the Manufacturer's instructions.
   2. Attach top and bottom runner channels at ends and at a maximum of 24 inches on center.
   3. Position studs vertically in runners, spaced a maximum of 16 inches on center.
   4. Install a deflection compensating top runner at partitions extending to the structure. Cut studs 1/2 inch shorter than the required length and fit into the top runner. Fasten studs to the top runner in a manner that permits runner movement.
   5. Locate studs a maximum of 2 inches from doorframes and abutting construction.
   6. Use double studs on both sides of the openings in partitions.
   7. Install a horizontal runner as a header above the openings in partitions. Install studs from the header to the top runner.
   8. Brace furred partitions with an adjustable bracket located at mid-height.
   9. Provide wood or metal bracing in partitions to receive and support fixtures, trim, accessories, and other applied items.
   10. Brace ceiling height partitions to the structure at a maximum of 48 inches on center.

B. Ceiling and Soffit Framing:
   1. Install in accordance with ASTM C 754 and the Manufacturer's instructions.
   2. Space hanger wires at a maximum of 48 inches on center along runner channels and within 6 inches of ends of channels, and secure to the structure above.
   3. Space runner channels at a maximum of 48 inches on center and within 6 inches of abutting construction.
      a. Position channels for ceiling height, level and saddle tie along channels.
      b. Provide 1 inch of clearance between channels and abutting construction.
      c. Overlap channel ends 12 inches at splices and secure each end with double loop tie wire.
   4. Space furring channels at a maximum of 16 inches on center, perpendicular to runners, and within 6 inches of abutting construction.
      a. Provide 1 inch clearance between channels and abutting construction.
      b. Secure to runners with clips on alternate sides of runners, saddle tie if clips cannot be alternated.
      c. Overlap channel ends 8 inches at splices and secure each end with double loop tie wire.
   5. Where openings interrupt furring or runner channels, install reinforcing to restore stability.

6. At exterior soffits, install a section of furring channel around each hanger wire with flanges cut and bent back. Extend the bent portion a minimum of 2 inches along runner channels and secure with screws and double loop tie wire. Fasten to the structure at the top.
7. Provide double runner or furring channels side-by-side where expansion and control joints occur. Do not continue channels over joints.

C. Gypsum Boards:
1. Install boards and accessories in accordance with ASTM C 754, GA 216, and the Manufacturer's instructions.
2. Accurately cut boards to fit around openings and projections. Do not tear the face paper or break the gypsum core.
3. Apply boards at non-fire rated assemblies in the most economical manner, with ends and edges occurring over supports.
4. Apply boards at fire rated assemblies as required by the design assembly.
5. Stagger joints on opposite sides of the partitions.
6. Do not locate joints to align with the edges of the openings unless a control joint is installed.
7. Mechanically fasten single layer boards to the framing. Place fasteners a minimum of 3/8 inch from the edges of boards, and drive heads slightly below the surface. Stagger fasteners at abutting edges.
8. Apply the face layer of double layer applications with joints offset from those in the base layer. Secure with mechanical fasteners to the framing or with adhesive to the base layer.
9. At deflection compensating head tracks, cut boards 1/2 inch short of the structure at the head, do not secure boards to the top runner channel.
10. Treat cut edges and holes in moisture-resistant gypsum board with joint sealant.
11. Where recessed items occur in fire rated partitions, box the item on all sides with gypsum board, as required, to maintain the continuity of the fire rating.

D. Acoustical Partitions:
1. Extend acoustical partitions past intersecting non-acoustical partitions.
2. Install acoustical insulation:
   a. Butt to framing members and adjacent construction.
   b. Carry around pipes, wiring, outlets, and other construction without voids.
   c. Press against one gypsum board surface to form a slight air space on the opposite side.
3. Seal acoustical partitions at the perimeter and around penetrations:
   a. Apply a continuous bead of sealer between gypsum board edges and adjacent construction.
   b. Seal the space between gypsum boards at control joints prior to installing the metal control joint.
   c. Apply sealer to penetrations through partitions.

E. Acoustical Insulation Above Ceilings:
1. Install acoustical insulation in a continuous layer. Butt tightly to adjacent insulation and to other construction.
2. Carry over pipes, wiring, boxes, and other construction without voids.

F. Cementitious Backer Units:
1. Install in accordance with the Manufacturer's instructions.
2. Apply boards horizontally, with ends occurring over supports; stagger end joints in adjacent rows.
3. Cut boards to fit around openings and projections.
4. Mechanically fasten boards to the framing at a maximum of 12 inches on center.

G. Accessories:
1. Install in accordance with the Manufacturer's instructions.
2. Install corner reinforcement at outside corners. Use single lengths where the length of the corner does not exceed the standard length.
3. Install casings where shown on the Drawings and where gypsum board abuts dissimilar materials or stops with the edge exposed.
4. Install control joints at ceilings:
   a. At a maximum of 50 feet on center.
   b. Where ceiling framing changes direction.
5. Install control joints at walls and partitions:
   a. At changes in backup material.
   b. At a maximum of 30 feet on center.
   c. Above the jambs of openings in partitions.

H. Joint Treatment:
1. Treat joints and fasteners in gypsum board in accordance with GA 214.
2. Levels of finish:
   a. Surfaces in plenums: Level 1 finish.
   b. Surfaces to receive tile: Level 2 finish.
   c. Surfaces to receive flat or eggshell paints: Level 4 finish.
   d. Surfaces to receive semi-gloss or gloss paints: Level 5 finish.

END OF SECTION

SECTION 09 30 00
TILE

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for tile.
- B. Related Sections:
  1. SECTION 07 92 00 – JOINT SEALANTS

1.2 REFERENCES
- A. American National Standards Institute (ANSI):
  1. A108.1B – Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar
  2. A108.10 – Installation of Grout in Tilework
  3. A118.4 – Modified Dry Set Cement Mortar
  4. A118.6 – Standard Cement Grouts for Tile Installation
  5. A118.7 – High Performance Cement Grouts for Tile Installation
  6. A118.10 – Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations
  7. A118.12 – Crack Isolation Membranes for Thin Set Ceramic Tile and Dimension Stone Installations
  8. A137.1 – Specifications for Ceramic Tile
- B. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. C 1288 – Standard Specification for Fiber-Cement Interior Substrate Sheets
  3. D 226 – Standard Specification for Asphalt Saturated Organic Felt Used in Roofing and Waterproofing
  4. D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
- C. Tile Council of North America (TCNA):
  1. Handbook for Ceramic, Glass, and Stone Tile Installation

1.3 SUBMITTALS
- A. Product Data: Manufacturer's installation, cleaning, and maintenance instructions.
- B. Samples:
  1. Tile: Full-size samples showing available colors.
  2. Grout: 1/2 inch by 1/2 inch by 3 inches long showing available colors.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Tile and Trim Units: In accordance with ANSI A137.1.
- C. Material Specifications: In accordance with ANSI A118.4, ANSI A118.6, ANSI A118.7, ANSI A118.10, and ANSI A118.12.
- D. Installation Specifications: In accordance with ANSI A108.1B and ANSI A108.10.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver mortar, adhesive, and grout containers bearing a hallmark certifying compliance with reference standards.
- B. Protect adhesive containers from moisture, freezing, and overheating in accordance with the Manufacturer's instructions.

1.6 SITE CONDITIONS
- A. Maintain a temperature of 60°F in the space to receive tile for 2 days before and 7 days after installation; subsequently maintain a 55°F minimum temperature.
- B. Ventilation: Provide ventilation by use of fans or a building HVAC system.
- C. Lighting: Maintain lighting at a minimum uniform level of 50 foot-candles where tile systems are being installed.

1.7 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the tile system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. TEC
- B. Unglazed Ceramic Mosaic Tile:
  1. Daltile, Keystones
- C. Glazed Ceramic Tile:
  1. Daltile, Color Wheel Collection, Classic
- D. Setting and Grouting:
  1. LATICRETE International Inc.
  2. MAPEI Corporation.
  3. TEC Specialty Products Inc.

E. Metal Edge Strips:
   1. Schluter
F. Waterproof Membrane:
   1. Custom Building Products, RedGard Waterproofing, and Crack Prevention Membrane

2.2 MATERIALS

A. Tile:
   1. Unglazed ceramic mosaic tile:
      a. Size: 2 inches by 2 inches by 1/4 inch thick.
      b. Edge: Square.
      c. Color: To be selected from the Manufacturer's full color range.
      d. Surface finish: Unglazed.
      e. Trim units: Cove, coved internal corner, bullnose, bullnose corner; color to match tile.
   2. Glazed ceramic tile:
      a. Size: 4 1/4 inches by 4 1/4 inches by 5/16 inch thick.
      b. Edge: Square.
      c. Color: To be selected from the Manufacturer's full color range.
      d. Surface finish: Matte.
      e. Trim units: bullnoses, bullnose corners, flat top cove bases, flat top cove base corners, sanitary cove base corners; color to match tile.
B. Mortar and Grout:
   1. Modified dry-set mortar:
      a. Polymer-modified thinset mortar, in accordance with ANSI A118.4.
      b. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water shall be added at the Project site.
      c. Color: To be selected from the Manufacturer's full color range.
   2. Portland cement mortar: In accordance with ANSI A108.1B.
   3. Standard Cement Grout:
      a. Latex polymer-modified portland cement grout, sanded, in accordance with ANSI A118.6.
      b. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water shall be added at the Project site.
      c. Color: To be selected from the Manufacturer's full color range.
   4. High Performance Grout:
      a. Premium, fine aggregate, polymer-modified, non-shrinking, stain resistant grout, in accordance with ANSI A118.7.
      b. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
      c. Color: To be selected from the Manufacturer's full color range.
   5. Water: Clean; potable.
C. Maintenance:
   1. Extra materials: 3% of each tile.

2.3 ACCESSORIES

A. Joint Sealants: As specified in SECTION 07 92 00.
B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic.
   1. Transition at similar height floor finishes: Anodized aluminum or SST, 0.125 inch wide at top edge, height as required for floor finish, with integral horizontal leg for anchorage to substrate. Finish selected by the ENGINEER.
   2. Transition at varying height floor finishes: Anodized aluminum or SST, with sloped transition between a higher floor finish and an adjoining lower surface. Height as required for floor finish. Provide with integral horizontal leg for anchorage to substrate. Schluter Reno-U. Finish selected by the ENGINEER.
C. Fiber Cement Underlayment: In accordance with ASTM C 1288.
D. Joint Reinforcing: 2-inch glass fiber mesh tape.
E. Fasteners: Use non-corrosive, non-oxidizing, hot-dipped fasteners in accordance with ASTM A 653 in wet areas.
F. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
G. Moisture-Resistant Membrane: In accordance with ASTM D 226, Type I, No. 30, non-perforated.
H. Waterproof Membrane: Elastomeric membrane, in accordance with ANSI A118.10 and ANSI A118.12.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to remove loose and foreign matter that could impair adhesion.
B. Remove ridges and projections. Fill voids and depressions with a patching compound that is compatible with setting materials.
C. Allowable Substrate Tolerances:
   1. Thin set method:
      a. Maximum variation in substrate surface: 1/8 inch in 8 feet.
      b. Maximum height of abrupt irregularities: 1/32 inch.
   2. Thick set method: Maximum 1/4 inch in 10 feet variation in substrate surface.
D. Test concrete substrate in accordance with ASTM D 4263; do not install tile until surfaces are sufficiently dry.
E. Lay out tile work and center tile fields in both directions in each space.

F. Install a waterproof membrane over the entire floor surface and allow it to cure prior to installing tile in accordance with the Manufacturer's recommendations.
G. Install a moisture-resistant membrane over the entire wall surface prior to installing tile in accordance with the Manufacturer's recommendations.

3.2 INSTALLATION

A. Install products in accordance with the Manufacturer's recommendations, ANSI specifications, and the TCNA Handbook for Ceramic, Glass, and Stone Tile Installation.
B. At areas requiring slope, apply bond coat and build up subfloor with mortar mix. At areas of the floor plan showing slope, provide 1/8 in/ft slope.
C. Minimize pieces less than half-size. Locate cuts to be inconspicuous.
D. Lay tile to the pattern shown on the Drawings. Do not interrupt tile pattern through openings.
E. For tile exhibiting color variations within the ranges selected, blend so that tile units are randomly installed.
F. Joint Widths:
    1. Unglazed ceramic mosaic tile: 1/8 inch
    2. Glazed ceramic tile: 1/16 inch
G. Make joints watertight, without voids, cracks, excess mortar, or excess grout. Align joints in the wall and the floor of same-sized tile.
H. Fit tile around projections and at the perimeter. Provide smooth and clean cut edges. Ensure that trim will completely cover cut edges.
I. Install Trim:
    1. Inside corners: Cove units.
    2. Outside corners: Bead units.
    3. Base: Base units.
    4. Exposed tile ends: Bullnose units.
J. Sound tile after setting and before grouting. Replace hollow sounding units.
K. Allow tile to set for a minimum of 2 days before grouting.
L. Grout tile joints in accordance with ANSI A108.10 without excess grout.
M. Clean tile work of grout film upon completion of the Work.
N. Control Joints:
    1. Provide control joints at:
        a. Changes in backup material.
        b. Changes in plane.
        c. Over joints in substrate.
        d. Maximum 36 feet on center at interior locations.
    2. Form joints in accordance with TCNA for Ceramic, Glass, and Stone Tile Installation, Method EJ-171.
    3. Install joint backing and joint sealant as specified in SECTION 07 92 00.
O. Install metal edge strips at tile terminations and joints with other floor finishes.
P. Setting Methods: In accordance with the Contract Documents.

3.3 PROTECTION

A. Provide protection for completed Work using nonstaining sheet coverings.
B. Prohibit traffic on tile floors for a minimum of 3 days after installation.

3.4 CLEANING

A. Clean tile and adjacent surfaces thoroughly after installation; rinse with clean water to remove cleaners.
B. Perform final cleaning within 5 days prior to the Substantial Completion date.

3.5 ADJUSTING

A. Remove and replace pieces damaged during installation.

END OF SECTION

INTENTIONALLY BLANK

SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for acoustical ceilings.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
  2. C 635 – Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
  3. C 636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
  4. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  5. E 1264 – Standard Classification of Acoustical Ceiling Products
- B. Ceiling and Interior Systems Construction Association (CISCA):
  1. Ceiling Systems Handbook

1.3 SUBMITTALS
- A. Product Data:
  1. Grid system.
  2. Acoustical panels.
- B. Samples:
  1. Acoustical panels: 6 inches by 6 inches.
  2. Suspension system samples showing each profile: 6 inch long.
- C. Quality Control Submittals: Provide certification from an independent testing laboratory that acoustical panels meet fire hazard classification requirements.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Fire Hazard Classification: Tested in accordance with ASTM E 84.
  1. Flame spread index: In accordance with ASTM E 1264 for Class A materials.
  2. Smoke developed index: 50 or less.

1.5 SITE CONDITIONS
- A. Maintain a temperature of 70°F in the space to receive acoustical ceilings for 2 days before and 4 days after installation; subsequently maintain a 55°F minimum temperature.

1.6 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the acoustical ceiling system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Suspension Grid System:
  1. Armstrong World Industries, Inc., Prelude XL
  2. Chicago Metallic Corporation
  3. USG Interiors, Inc.
- B. Acoustical Panels, 24 inches by 48 inches by 3/4 inch thick:
  1. Armstrong World Industries, Inc., Ultima 1914
  2. CertainTeed Gypsum, Inc., SYMPHONY m 1220BB-75-1
  3. USG Interiors, Inc. Mars Acoustical Panel 88785
- C. Acoustical Panels, 24 inches by 48 inches by 5/8 inch thick:
  1. Armstrong World Industries, Inc., VL 871
  2. CertainTeed Gypsum, Inc.
  3. USG Interiors, Inc.

2.2 MATERIALS
- A. Suspension Grid System:
  1. Intermediate duty, die cut, interlocking ends, in accordance with ASTM C 635.
  2. Grid type: Exposed T.
  3. Material: Galvanized steel.
  4. Runners: 1 1/2 inches high, 15/16 inch exposed width, flush profile.
  5. Perimeter molding: Angle shape.
  6. Finish: Factory-applied polyester paint, sprayed and baked, white color.
  7. Accessories: Stabilizer bars, clips, and splices.

B. Acoustical Panels:
1. Size: 24 inches by 48 inches by 3/4 inch thick.
2. Edge configuration: 15/16-inch beveled tegular.
3. Performance requirements:
a. Tested in accordance with ASTM E 1264, Type IV, Form 2, Pattern E.
1) NRC: 0.75.
2) CAC: 35.
3) LR: 0.90.
b. Tested in accordance with ASTM E 84:
1) Flame spread: 25.
2) Smoke developed: 50.

C. Acoustical Panels:
1. Size: 24 inches by 48 inches by 5/8 inch thick.
2. Edge configuration: Square.
3. Performance requirements:
a. Tested in accordance with ASTM E 1264, Type IV, Form 2, Pattern CE:
1) NRC: 0.55.
2) CAC: 35.
3) LR: 0.78.
b. Tested in accordance with ASTM E 84.

D. Maintenance:
1. Extra materials: Minimum 2% of acoustical panels; not less than 10 units.
2. Grid: 20 linear feet.

2.3 ACCESSORIES
A. Support Channels: Steel, size and type to suit the application.
B. Hanger Wire: Minimum 12 gauge galvanized steel, in accordance with ASTM A 641.
C. Hold Down Clips: Minimum 24 gauge spring steel, Manufacturer's standard profile.
D. Impact Clips: Minimum 24 gauge spring steel, Manufacturer's standard profile.
E. Touch Up Paint: Color to match acoustical panels and suspension grid.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install ceilings in accordance with ASTM C 636 and the CISCA Ceiling Systems Handbook.
B. Follow the requirements of the reflected ceiling plan for grid layout.
C. Measure each ceiling area and establish the layout of acoustical units to balance border widths at opposite edges of each ceiling.
D. Minimize panels less than half-size.
E. Install molding around perimeters and abutting surfaces.
1. Miter molding at exterior corners; cut flanges and bend web to form interior corners.
2. Securely fasten the vertical leg of the edge moldings to the wall. Secure no more than 3 inches from each end and no more than 16 inches on center along the molding.
F. Locate hangers a maximum of 12 inches from grid ends.
G. Space hanger wires a maximum of 48 inches on center.
H. Install additional hangers to provide a maximum of 24 inches on center spacing of supports where light fixtures, grilles, or other concentrated loads are hung from structure.
I. Do not suspend hangers directly from metal deck.
J. Hang the suspension system independent of walls, columns, ducts, pipes, and conduit.
K. Where ducts or other equipment prevent the regular spacing of hangers:
1. Reinforce the nearest related hangers to span the extra distance; or
2. Suspend the steel channel horizontally beneath the duct or equipment; place hanger at regular spacing.
L. Install main tees at a maximum of 48 inches on center.
M. Install cross tees to form the spacing shown on the Drawings. Lock cross tees to main tees.
N. Support ends of tees on the flange of perimeter molding.
O. Place acoustical panels with edges resting flat on the suspension grid.
P. Install acoustical panels with the pattern running in one direction.
Q. Cutting Acoustic Units:
1. Cut to fit irregular grid, perimeter edge trim, and around penetrations.
2. Locate cuts to be concealed.
3. Cut and field paint exposed edges of reveal edge units to match factory edge.
R. Place hold down clips over cross tees at the mid-point of each module.
S. Place impact clips over cross tees at the mid-point of each module.
T. Lighting Fixture Protection: Form a trapezoidal, 5-sided box of acoustical panels cut to size over each light fixture; conform to UL requirements.
U. Installation Tolerances: Ceilings level to 1/8 inch in 12 feet measured in any direction.

3.2 ADJUSTING
A. Touch up minor scratches and abrasions to match the factory finish.
B. Replace damaged and broken panels.

END OF SECTION

SECTION 09 65 13
RESILIENT BASE

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for resilient base.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  2. E 662 – Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
  3. F 1861 – Standard Specification for Resilient Wall Base

1.3 SUBMITTALS
- A. Product Data: Provide data on specified products describing physical and performance characteristics.
- B. Samples: 4 inches long showing available colors.
- C. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Fire Hazard Data:
  1. Flammability: Class B, tested in accordance with ASTM E 84.
  2. Smoke density: 450 or less, tested in accordance with ASTM E 662.

1.5 SITE CONDITIONS
- A. Maintain a temperature of 70°F in the space to receive resilient base for 1 day before and 2 days after installation; subsequently maintain a 55°F minimum temperature.

1.6 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the resilient base system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Flexco, Wallflowers
- B. Mannington Commercial, BurkeBase TS
- C. Roppe Corporation, Pinnacle
- D. Tarkett, Baseworks

2.2 MATERIALS
- A. Resilient Base:
  1. Type: In accordance with ASTM F 1861, Type TS thermoset vulcanized rubber Group 1.
  2. Thickness: 0.125 inch.
  3. Profile: Straight Style A at carpet and coved Style B at resilient tile.
  4. Height: 4 inches.
  5. Length: 120 feet, continuous rolls.
  6. Color: To be selected from the Manufacturer's full color range.
  7. End units and preformed inside and outside corners: Preformed; profile, size, and color to match base.
- B. Maintenance:
  1. Extra materials: 2% of each profile and color.

2.3 ACCESSORIES
- A. Adhesive: Water-based, waterproof, recommended by the Base Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION
- A. Prepare surfaces to receive base:
  1. Remove materials that could interfere with adhesion.
  2. Fill low spots with a patching compound; finish flush with adjacent surface.
  3. Remove high spots, ridges, and nibs.

3.2 INSTALLATION
- A. Apply adhesive continuously to the back of base.
- B. Lay and install base to maximize the lengths between joints.
- C. Maintain the top edge true to line and the bottom edge in continuous contact with the floor. Butt joints tightly and butt the base tightly to adjacent construction.
- D. Do not install pieces less than 6 inches long.
- E. Install internal corners from preformed material or fabricated from base materials or mitered and coped.
- F. At outside corners use preformed material or a V-cut back of base to 2/3 of its thickness and bend around the corner.
- G. At exposed ends, install premolded units.
- H. Scribe to door frames and other interruptions.

END OF SECTION

INTENTIONALLY BLANK

SECTION 09 65 16
SHEET VINYL FLOORING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for sheet vinyl flooring.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. E 648 – Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
  2. E 662 – Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
  3. F 970 – Standard Test Method for Static Load Limit
  4. F 1303 – Standard Specification for Sheet Vinyl Floor Covering with Backing
  5. F 1516 – Standard Practice for Sealing Seams of Resilient Flooring Products by the Heat Weld Method
  6. F 1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

1.3 SUBMITTALS
- A. Product Data: Provide data on specified products describing physical and performance characteristics.
- B. Samples:
  1. Tile: 2 inches by 2 inches showing the available colors.
  2. Heat-welding beads: 4 inches long showing the available colors.
- C. Quality Control Submittal: Provide certification from an independent testing laboratory that flooring meets the specified physical properties and the fire hazard classification requirements.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Fire Hazard Data:
  1. Classification: Class I rated, tested in accordance with ASTM E 648.
  2. Smoke density : 450 or less, tested in accordance with ASTM E 662.
- C. Static Load Limit: 500 psi minimum, tested in accordance with ASTM F 970.

1.5 SITE CONDITIONS
- A. Maintain a temperature between 70°F and 90°F in the space to receive sheet vinyl flooring for 1 day before and 2 days after installation; subsequently maintain a 55°F minimum temperature.

1.6 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the sheet vinyl flooring system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Armstrong World Industries, Corlon
- B. Mannington Resilient Floors, Terrene

2.2 MATERIALS
- A. Sheet Vinyl:
  1. Classification: In accordance with ASTM F 1303, Type II, Grade 1, Class A Backing.
  2. Construction: Homogeneous sheet.
  3. Description: Inlaid sheet flooring consisting of an embossed wear layer of vinyl granules consolidated on a flexible fibrous backing, with the color uniformly dispersed through the wear layer, and a cured polyurethane finish.
  4. Width: The Manufacturer’s standard 6 feet or 6 feet 6 inches.
  5. Thickness:
     a. Total: 0.080 inch.
     b. Wear layer: 0.050 inch.
  6. Seaming: Heat-weld.
  7. Color: To be selected from the Manufacturer's full color range.
- B. Maintenance:
  1. Extra materials: 2% of each color and pattern.

2.3 ACCESSORIES
- A. Heat-Welding Bead: Solid-strand product of the Floor Covering Manufacturer for heat-welding seams; color to be selected from the Manufacturer's full color range.
- B. Leveling Compound: Latex-modified, portland cement based formulation provided or approved by the Flooring Manufacturer.
- C. Primer: A product compatible with the patching and leveling compound for substrates as recommended by the Flooring Manufacturer.
- D. Adhesive: The type recommended by the Flooring Manufacturer.
- E. Cove Strip: 1 inch radius support for integral flash cove base provided or approved by the Floor Covering Manufacturer.

F. Cove-Base Cap Strip: A square metal cap for integral flash cove base provided or approved by the Floor Covering Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that concrete floors have cured for a minimum 28 days and do not exhibit negative alkalinity, carbonization, or dusting.
B. Inspect subfloor surfaces to ensure they are smooth and free from cracks, holes, ridges, coatings preventing adhesive bond, and other defects impairing performance or appearance.
C. Verify that substrate conditions are acceptable for product installation in accordance with the Manufacturer's instructions.
D. Clean substrate of loose and foreign matter that could impair bond.
E. Fill cracks, voids, and depressions in the substrate with leveling compound.
F. Grind off high spots and projections in the substrate; leave smooth and level to 1/4 inch in 10 feet.
G. Test the substrate for moisture content in accordance with ASTM F 1869; do not install flooring until the moisture emission level is acceptable to the Flooring Manufacturer.
H. Prior to the application of adhesive, apply concrete slab primer as recommended by, and in compliance with, the Flooring Manufacturer's directions.

3.2 INSTALLATION

A. Tile:
   1. Install tile in accordance with the Manufacturer's instructions.
   2. Unroll sheet vinyl floor coverings and allow them to stabilize before cutting and fitting if recommended by the Manufacturer.
   3. Lay out sheet vinyl floor coverings to comply with the following requirements:
      a. Maintain uniformity in the sheet vinyl floor covering direction.
      b. Arrange for a minimum number of seams; place seams in inconspicuous and low-traffic areas no less than 6 inches away from parallel joints in flooring substrates.
      c. Match the edges for color shading and pattern at the seams in accordance with the Manufacturer's recommendations.
   4. Scribe, cut, and fit sheet vinyl floor coverings to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
   5. Integral flash cove base: Where shown on the Drawings, cut sheet vinyl floor coverings to form an integral base of the height shown on the Drawings at vertical surfaces.
   6. Adhere sheet vinyl floor coverings to flooring substrates in accordance with the Floor Covering Manufacturer's instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
      a. Produce the completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
      b. Form an integral flash cove base by flashing floor covering up vertical surfaces. Support floor covering at the horizontal and vertical junction with a cove strip. Butt floor covering at the top of the base against the cap strip.
   7. Heat-welded seams: Rout joints and heat weld with welding bead, permanently fusing sections into a seamless floor covering. Prepare, weld, and finish seams in accordance with the Manufacturer's instructions and ASTM F 1516 to produce surfaces flush with adjoining floor covering surfaces.
   8. Sheet vinyl floor coverings:
      a. In corridors, lay with seams running crosswise, spaced the full width of the roll; at terminations and intersections, keep seams less than 1/2 width of the roll.
      b. Where seams occur at right angle corridors, cut pieces that butt each other from the same roll.
B. Reducer Strips:
   1. Install where the tile stops with the edge exposed and set in adhesive.
   2. Center strips under doors where flooring terminates at door openings.
   3. Install in the longest practicable lengths and butt ends tightly.
   4. Scribe to abutting surfaces.

3.3 PROTECTION

A. Do not allow traffic on the flooring until the adhesive has set.
B. Cover areas that are subject to traffic with protective covering.

3.4 CLEANING

A. Clean the tile and machine buff in accordance with the Manufacturer's instructions.

END OF SECTION

SECTION 09 65 19
RESILIENT TILE FLOORING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for resilient tile flooring.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 2047 – Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
  2. E 648 – Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
  3. E 662 – Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
  4. F 1066 – Standard Specification for Vinyl Composition Floor Tile
  5. F 1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

1.3 SUBMITTALS
- A. Product Data: Provide data on specified products describing physical and performance characteristics.
- B. Samples:
  1. Tile: 2 inches by 2 inches showing available colors.
  2. Reducers: 4 inches long showing available colors.
- C. Quality Control Submittals: Provide certification from an independent testing laboratory that flooring meets fire hazard classification requirements.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Installer Qualifications:
  1. A minimum of 5 of years documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- B. Fire Hazard Classification:
  1. Class I rated, tested in accordance with ASTM E 648.
  2. Smoke density: 450 or less, tested in accordance with ASTM E 662.
- C. Static Coefficient of Friction: Minimum 0.5, tested in accordance with ASTM D 2047.

1.5 SITE CONDITIONS
- A. Maintain a temperature between 70°F and 90°F in the space to receive resilient tile flooring for 1 day before and 2 days after installation; subsequently maintain a 55°F minimum temperature.

1.6 WARRANTY
- A. Warranty:
  1. Installation: 1 year from the Substantial Completion date for the satisfactory performance and installation of the resilient tile flooring system and associated appurtenances.
  2. Material: 5 year limited warranty for material manufacturing defects.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Vinyl Composition Tile:
  1. Armstrong World Industries, Standard Excelon Imperial Texture
  2. Tarkett, Inc., VCT

2.2 MATERIALS
- A. Vinyl Composition Tile:
  1. Classification: In accordance with ASTM F 1066, Class 2 through pattern.
  2. Size: 12 inches by 12 inches by 1/8 inch thick.
  3. Color: To be selected from the Manufacturer's full color range.
- B. Maintenance:
  1. Extra materials: 2%, but not less than one carton, of each color and pattern.

2.3 ACCESSORIES
- A. Reducer Strips: Solid vinyl or rubber composition, 1 inch wide by tile thickness, tapered; color to be selected from the Manufacturer's full color range.
- B. Leveling Compound: White, pre-mixed, latex-based.
- C. Adhesive: Water-based, waterproof, recommended by the Flooring Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION
- A. Verify concrete floors have cured for a minimum of 28 days and do not exhibit negative alkalinity, carbonization, or dusting.
- B. Inspect subfloor surfaces to determine they are smooth and free from cracks, holes, ridges, coatings preventing adhesive bond, and other defects impairing performance or appearance.
- C. Clean the substrate of loose and foreign matter that could impair bond.
- D. Fill cracks, voids, and depressions in the substrate with leveling compound.
- E. Grind off high spots and projections in the substrate; leave smooth and level to 1/4 inch in 10 feet.

F. Test the substrate for moisture content in accordance with ASTM F 1869; do not install flooring until the moisture emission level is acceptable to the Flooring Manufacturer.
G. Prior to the application of adhesive, apply concrete slab primer as recommended by and in compliance with the Flooring Manufacturer's directions.

3.2 INSTALLATION

A. Tile:
1. Install tile in accordance with the Manufacturer's instructions.
2. Mix tile from the container to ensure shade variations are consistent when tile is placed.
3. Layout the tile to provide equal sized tiles at opposing walls and with the grain in the tile running in one direction in each room or area.
4. Spread only enough adhesive to permit the installation of materials before initial set.
5. Lay flooring with joints parallel to building lines to produce a symmetrical tile pattern.
6. Install tile with neat joints, laid tightly, even, and straight.
7. Install tile to the pattern shown on the Drawings. Allow minimum half-size tiles at room or area perimeter.
8. Tightly cement flooring to the sub-base; press with a heavy roller to attain full adhesion without open cracks, voids, raising, and puckering at joints, telegraphing of adhesive spreader marks or other surface imperfections.
9. Scribe flooring to walls, columns, cabinets, and other appurtenances to produce tight joints. Ensure base, trim, plates, or escutcheons will completely cover cut edges.
10. Extend tile into recesses and under equipment.
11. Terminate flooring at the centerline of door openings where the adjacent floor finish is dissimilar.

B. Reducer Strips:
1. Install where tile stops with the edge exposed; set in adhesive.
2. Center strips under doors where flooring terminates at door openings.
3. Install in the longest practicable lengths; butt ends tightly.
4. Scribe to abutting surfaces.

3.3 PROTECTION

A. Do not allow traffic on the flooring until the adhesive has set.
B. Cover areas subject to traffic with a protective covering.

3.4 CLEANING

A. Clean tile and machine buff in accordance with the Manufacturer's instructions.

3.5 ADJUSTING

A. Correct tiles that are not seated; replace damaged tiles.

END OF SECTION

SECTION 09 67 16
RESINOUS FLOORING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for resinous flooring.
- B. Related Sections:
  1. SECTION 07 92 00 – JOINT SEALANTS
  2. SECTION 09 90 00 – PAINTING AND COATING
  3. SECTION 09 97 00 – CHEMICAL CONTAINMENT COATING SYSTEMS

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. C 307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
  2. C 579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
  3. C 580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
  4. D 638 – Standard Test Method for Tensile Properties of Plastics
  5. D 2240 – Standard Test Method for Rubber Property – Durometer Hardness
  6. D 4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
  7. D 4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
  8. F 1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
  9. F 2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
- B. International Concrete Repair Institute (ICRI):
  1. Technical Guideline No. 310.2R – Selecting and Specifying Concrete Surface Preparation
- C. The Society for Protective Coatings/NACE International (SSPC/NACE):
  1. SSPC SP 13/NACE No. 6 – Surface Preparation of Concrete

1.3 SUBMITTALS
- A. Product and Safety Data: Provide data on specified components describing physical and performance characteristics, as well as SDS.
- B. Samples: Minimum 6 inches by 6 inches showing the available colors, textures, and finishes.
- C. Qualification Data: Submit letter for proof of acceptability of the Applicator by the Manufacturer.
- D. QC Submittal: Provide certification from an independent testing laboratory that flooring meets the specified physical properties and requirements. Include chemical resistance information and product suitability for locations exposed to chemicals or oil.
- E. Jobsite Reports: Submit at the completion of Work
  1. Daily Reports: Include surface preparation, substrate temperature, ambient air temperature, application procedures, materials applied, material quantities, material batch number, description of work completed, and location.
  2. The Applicator shall maintain a copy of records until the expiration of the specified warranty period.
- F. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. System Physical Properties:
  1. System performance criteria:
     a. Hardness at 1 day, Shore D: 70/65 tested in accordance with ASTM D 2240.
     b. Compressive strength: 12,000 psi, tested in accordance with ASTM C 579.
     c. Tensile strength:
        1) 1,900 psi tested in accordance with ASTM C 307.
        2) 6,000 psi tested in accordance with ASTM D 638.
     d. Abrasion resistance: 90 mg to 100 mg lost, tested in accordance with ASTM D 4060, CS-17 wheel, 1,000 cycles.
     e. Adhesion: 300 psi or at concrete failure.
  2. Verify flooring system is resistant to chemicals present in the service area.
- D. Applicator Qualifications:
  1. The Applicator shall be qualified by the Manufacturer prior to bid date.
  2. Installation equipment shall be acceptable to the Manufacturer.
  3. Establish QC procedures and practices to monitor phases of surface preparation, storage, mixing, application, and inspection throughout the duration of the Project.

4. The Applicator's QC procedures and practices shall include the following items:
    a. Training of personnel in the proper surface preparation requirements.
    b. Training of personnel in the proper storing, mixing, and application and QC testing.
5. Provide a list of no fewer than five projects using equivalent materials.

E. Mockups: Apply mockups of each system to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Apply full-thickness mockups on 48 sq-in floor area selected by the ENGINEER.
    a. If required include 48 inch length of integral cove base.
2. Simulate finished lighting conditions for the ENGINEER's review of mockups.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion date.

F. Pre-Installation Conference:
1. Before installing mock-ups, the General Contractor, Applicator, ENGINEER, and Manufacturer's Technical Representative shall meet on-site with the ENGINEER to discuss approved products and workmanship to ensure proper application of the products and substrate preparation requirements.
2. Review foreseeable methods and procedures related to the Work including but not necessarily limited to the following:
    a. Project requirements and the Contract Documents.
    b. Required Submittals.
    c. Status of substrate Work, including approval of surface preparations and similar considerations.
    d. Requirements of on-site QC inspection and testing.
    e. The requirements for preparing the QC report as specified herein.
    f. Availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
    g. Material storage and staging.
    h. Equipment storage and staging.
    i. Waste management and disposal.
    j. Environmental conditions, other project conditions, and procedures for coping with unfavorable conditions.
    k. Regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
    l. Procedures required for the protection of the completed Work during the remainder of the construction period.

G. Single-Source Responsibility:
1. Materials shall be products of a single Manufacturer or items standard with the Manufacturer of specified resinous floor coating materials.
2. Provide secondary materials which are produced or are specifically recommended by the Resinous Floor Coating System Manufacturer to ensure compatibility of the system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in the Manufacturer's undamaged, unopened containers clearly marked with the product name, Manufacturer name, component designations, product mix ratio, and health and safety information.

B. Store materials until use in accordance with the Manufacturer's instructions.

C. Do not use materials that exceed the Manufacturer's maximum recommended shelf life.

1.6 SITE CONDITIONS

A. Adhere to the Manufacturer's instructions for ambient humidity, ambient temperature, substrate temperature, moisture, ventilation, and other conditions affecting resinous floor application for the duration of application and product curing.

B. The substrate temperature shall be a minimum of 5°F above the dew point during installation.

C. Lighting: Maintain lighting at a minimum uniform level of 50 foot-candles where the flooring system is being installed.

D. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless the Manufacturer recommends a longer period.

1.7 WARRANTY

A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the resinous flooring system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Dur-A-Flex
B. Stonhard
C. Sherwin Williams
D. Tnemec

2.2 MATERIALS

A. Description: Abrasion, impact, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor.

B. System Components:
1. Primer/base coat: Urethane cement slurry.
    a. Flexural strength: 2,200 psi, minimum, in accordance with ASTM C 580.
2. Slurry/aggregate: Granular quartz aggregate.
3. Intermediate (optional): Urethane or modified aliphatic polyaspartic.
4. Topcoat: Urethane or modified aliphatic polyaspartic.
5. Thickness: In accordance with the Manufacturer's specifications.
6. Color: To be selected from the Manufacturer's full color range.

C. Accessory Materials:
1. Patching and fill material: Resinous product of or approved by the Manufacturer and recommended by the Manufacturer for application indicated. ENGINEER approval is required prior to installation of specialty patching and filler products.
2. Joint sealant: Type recommended or produced by the Manufacturer and as specified in SECTION 07 92 00.

PART 3 EXECUTION

3.1 PREPARATION
A. Prepare concrete surfaces in accordance with SSPC SP 13/NACE No. 6.
B. Verify that substrate conditions are acceptable for product installation in accordance with the Manufacturer's instructions.
C. Clean substrate of existing coating, as well as loose and foreign matter that could impair bond.
D. Mechanically abrade the surface utilizing an abrasive blast method to a uniform texture, with a surface profile equal to ICRI Technical Guideline 310.2R, CSP 4-6, refer to Form G-1.
E. After initial preparation, inspect the surface for bug holes, voids, fins, and other imperfections.
1. Immediately notify the ENGINEER of poor substrate condition.

3.2 INSTALLATION
A. Install coatings for floor trenches, equipment pads, drains, and other miscellaneous features to ensure a complete coating system. Do not add grit to coatings in drains, trenches, or other areas that will not see foot traffic.
1. Coordinate with coatings application specified in SECTION 09 90 00.
2. If flooring is part of a chemical containment system, apply chemical resistant topcoat as specified in SECTION 09 97 00.
B. Install each component of the flooring system in accordance with the Manufacturer's instructions. Strictly adhere to mixing and installation methods, recoat windows, cure times, and environmental restrictions.
C. Install system in the proper sequence, with the recommended layers and thickness in accordance with the Manufacturer's instructions for the system.
D. Install the system to terminate at the edge of isolation and expansion joints.
E. Apply primer over the prepared substrate at the Manufacturer's recommended spreading rate.
F. Apply self-leveling slurry body coats in the thickness recommended by the Manufacturer.
G. Broadcast aggregates and, after the resin has cured, remove excess aggregates to provide the surface texture approved during sample and mockup review.
H. Apply troweled or screeded body coats in the thickness approved by the Manufacturer.
I. Integral Cove Base:
1. Apply the cove base mix to wall surfaces at the locations shown on the Drawings, round internal and external corners.
2. Install the cove base in accordance with the Manufacturer's instructions and details including taping, mixing, priming, troweling, sanding, and topcoating of the cove base.
J. Apply sealing or finish coats of the type recommended by the Manufacturer to produce the finish as shown on the Drawings.
K. Back roll with a short nap roller to even the texture and eliminate trowel marks and puddling.

3.3 PROTECTION
A. Protect equipment from dust, abrasives, and other contaminants throughout the entirety of surface preparation and application. Protect existing equipment, including but not limited to gates, valves, motors, electrical cabinets, sump pumps, and any other miscellaneous equipment with two layers of plastic, sealed completely with tape. Protection enclosures shall be air tight and taped to prevent any ingress of blast media or grinding effluent into existing equipment. Abrasive blast and grinding may not be performed until the ENGINEER approves protection of equipment. If abrasive blast media enters equipment, the CONTRACTOR is fully responsible for removing blast media from equipment or replacing equipment if damaged.
B. Protect flooring from contamination during installation and prior to the completion of curing.
C. Cure in accordance with the Manufacturer's instructions, allowing the system to cure for a minimum of 1 day prior to foot traffic.
D. Protect completed flooring from damage and wear as recommended by the Manufacturer.
E. Clean flooring 5 days prior to the Substantial Completion date with materials and procedures suitable to the System Manufacturer.

3.4 QUALITY CONTROL
A. Inspection:
1. Surface profile:
a. Inspect and record the substrate profile as recommended by the Resinous Floor Coating Manufacturer in accordance with ICRI Technical Guideline 310.2R and SSPC SP13/NACE No. 6.
1) Compare and record the substrate profile once every 50 sf with the concrete surface profile comparators in accordance with ICRI Technical Guideline No. 310.2R.
2. Measure and record ambient air temperature, relative humidity and dew point temperature once every 2 hours of each work shift.
3. Concrete moisture testing: After surface preparation verify concrete dryness in accordance with ICRI Technical Guideline 310.2R and SSPC SP13/NACE No. 6 and the following test methods. Testing is not required for flooring that includes moisture vapor transmission mitigation.
a. Measure the moisture vapor transmission rate of the concrete subfloor in accordance with ASTM F 1869.
b. Moisture vapor transmission not to exceed 20 lbs/1,000 sf in a 24-hour period.

c. Measure relative humidity of the concrete floor prior to coating application in accordance with ASTM F 2170.
d. Relative humidity not to exceed 99%.
e. Consult the Manufacturer regarding questions and or recommendations in reference to moisture problems.

4. Wet film thickness: Measure thickness of pre-cured coatings in accordance with ASTM D 4414.

3.5 CLEANING

A. Clean flooring 5 days prior to the Substantial Completion date with materials and procedures suitable to the System Manufacturer.

END OF SECTION

SECTION 09 84 14
METAL ACOUSTICAL PANELS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for metal acoustical panels.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. C 423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
  3. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
  4. E 795 – Standard Practices for Mounting Test Specimens During Sound Absorption Tests

1.3 SUBMITTALS
- A. Product Data for metal panels including construction details, material descriptions, performance, and finish data.
- B. Shop Drawings: Indicate the layout of panels, and the location of trim, accessories, and penetrations.
- C. Samples:
  1. Each color of panel: 6 inches by 6 inches.
  2. Each trim profile: 6 inches long.
- D. Warranty Documentation:
  1. Sample warranty.
  2. Warranty.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Performance Requirements:
  1. For sound absorption, provide panels certified to meet the following minimum sound absorption for a 30 inch by 120-inch panel, encapsulated in a 2.0 mil flame guard PE, when tested in accordance with ASTM C 423 and ASTM E 795:
     a. 125 Hz: 6.2 sabins.
     b. 250 Hz: 20.5 sabins.
     c. 500 Hz: 35.2 sabins.
     d. 1,000 Hz: 34.5 sabins.
     e. 2,000 Hz: 31.5 sabins.
     f. 4,000 Hz: 33.1 sabins.
     g. NRC: 0.99, minimum.
  2. Fire: Provide panels that demonstrate the following performance when tested in accordance with ASTM E 84:
     a. Flame spread: 10 feet maximum.
     b. Smoke density: 10 maximum.

1.5 WARRANTY
- A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the metal acoustical panel system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Acoustical Solutions, Alphaperf
- B. Gordon Incorporated, ALPRO Acoustical Systems
- C. Eckel Industries, Inc., Eckoustic Functional Panels
- D. IAC Acoustics

2.2 MATERIALS
- A. Acoustic Panel System:
  1. Facing sheets:
     a. Structural quality, 22 gauge core steel, electrogalvanized in accordance with ASTM A 653, G90 coating class.
     b. Perforated with 3/32 inch holes on 3/16 inch staggered centers.
     c. Maximum deflection: 1/240 of the span as measured diagonally across the panel.
     d. Sides and top flanged.
  2. Framing:
     a. Structural quality, 20 gauge core steel, electrogalvanized in accordance with ASTM A 653, G90 coating class.
     b. Supply each member with two threaded inserts.
  3. Support brackets:
     a. Structural quality, 11 gauge core steel, in accordance with ASTM A 653, G90 coating class.
     b. Configure brackets to provide 4 inches of clearance from panel to mounting surface.
  4. Acoustical insulation: 2 inch thick fine fibered fibrous glass, with a density of not less than 1.5 lb/cf encapsulated in a 1.5 mil to 2 mil thickness flame guard PE.
  5. Finish:
     a. Factory-applied polyurethane enamel; color to be selected from the Manufacturer's standards.

b. Apply finish to both sides of the facing sheet, exposed framing members, and brackets.

B. Maintenance:
1. Extra materials: 2% of each profile and color.

2.3 ACCESSORIES

A. Fasteners:
1. Cadmium-plated steel, the type best suited to the application.
2. Finish fastener heads to match panels where exposed to view.

B. Hanger Wire: Galvanized steel, with the gauge required by the design loads.

2.4 FABRICATION

A. Panels and Accessories:
1. Panel thickness: 2 3/4 inches.
2. Panel profile: V-ridged on 6 inch centers.
3. Width: 30 inches.
4. Trim: Steel profiles as shown on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.

B. Walls:
1. Set panels straight, plumb, and rigid.
2. Overlap adjacent sheets one full corrugation; lap ends 2 inches at a minimum.
3. Accurately cut panels to fit at the perimeter and around penetrations.
4. Provide trim where panels abut dissimilar materials or stop with the edge exposed.

C. Ceilings:
1. Install a suspension grid with lines true, straight, and in alignment.
2. Suspend grid components from the structure with hanger wires spaced a maximum of 4 feet on center.
3. Set panels with edges resting on grid flanges; fully conceal panel edges.
4. Apply acoustical insulation over the top of the completed ceiling.

D. Installation Tolerances: Surfaces level to 1/4 inch in 10 feet.

3.2 ADJUSTING

A. Touch up minor scratches and abrasions to match the factory finish.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for painting and coating.

B. Related Sections:

1. SECTION 09 67 16 – RESINOUS FLOORING
2. SECTION 09 97 13.01 – POLYURETHANE COATINGS
3. SECTION 09 97 13.02 – LIQUID-EPOXY LININGS AND COATINGS

1.2 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):

1. Z535.1 – American National Standard for Safety Colors

B. American Water Works Association (AWWA):

1. C550 – Protective Interior Coatings for Valves and Hydrants

C. ASTM International (ASTM):

1. D 523 – Standard Test Method for Specular Gloss
2. D 4258 – Standard Practice for Surface Cleaning Concrete for Coating
3. D 4442 – Standard Test Method for Direct Moisture Content Measurement of Wood and Wood-Base Materials
4. D 6386 – Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

D. Electrical Industries Alliance (EIA):

1. 359 – Colors for Color Identification and Coding

E. Environmental Protection Agency (EPA):

1. 40 CFR 261 – Identification and Listing of Hazardous Waste
2. AP-42 – Compilation of Air Pollutant Emission Factors – Volume I: Stationary Point and Area Sources, Chapter 13.2.6 – Abrasive Blasting

F. NACE International (NACE):

1. SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
2. SP0287 – Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

G. National Association of Pipe Fabricators (NAPF):

1. 500-03 – Surface Preparation Standard For Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

H. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

I. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910 – Occupational Safety and Health Standards
2. 29 CFR 1926 – Safety and Health Regulations for Construction

J. The Society for Protective Coatings (SSPC):

1. PA 2 – Determining Compliance to Required DFT
2. PA Guide 10 – Contractor ESH Requirements
3. QP 1 – Field Industrial Contractor Qualification
4. SP 1 – Solvent Cleaning
5. SP 2 – Hand Tool Cleaning
6. SP 3 – Power Tool Cleaning
7. SP 8 – Pickling
8. SP 11 –Bare Metal Power Tool Cleaning
9. SP 16 – Brush-Off Blast Cleaning and Non-Ferrous Metals

K. The Society for Protective Coatings/NACE International (SSPC/NACE):

1. SP 6/NACE No. 3 – Commercial Blast Cleaning
2. SP 7/NACE No. 4 – Brush-Off Blast Cleaning
3. SP 10/NACE No. 2 – Near-White Blast Cleaning
4. SP 13/NACE No. 6 – Surface Preparation of Concrete
5. SP WJ-1/NACE WJ-1 – Waterjetting to Bare Substrate

1.3 DEFINITIONS

A. Coverage: Total minimum DFT in mils or sfpg.

B. Paint: The term paint, as used herein, means coating systems materials including primers, sealers, fillers, emulsions, enamels, epoxy, stains, lacquers, varnishes, and other applied materials, whether used in prime coats, intermediate coats, or finish coats.

C. Gloss Levels: Paint gloss levels specified herein are based on the following ranges:

Description	Gloss Range	ASTM D 523 Test Method
Flat	0 to 15	85°
Eggshell	5 to 20	60°
Satin	15 to 35	60°
Semi-Gloss	30 to 65	60°
Gloss	Over 65	60°

1.4 SEQUENCING AND SCHEDULING

A. Work Not Included:
   1. Surfaces in concealed or inaccessible areas such as furred spaces, foundation spaces, pipe or duct chases, shafts, or utility tunnels.
   2. Surfaces of anodized or prefinished aluminum, SST, bronze, brass, and chromium plate.
   3. Moving parts of operating equipment, mechanical or electrical moving parts, linkages, sensing devices, and motor shafts.
   4. Buried concrete surfaces.
   5. Nonmetallic materials such as glass and porcelain.
   6. Prefinished electrical items such as motors, MCCs, switchboards, switchgear, panelboards, transformers, and disconnect switches.
   7. Prefinished architectural items such as acoustical tile, cabinets, building louvers, overhead coiling doors, sectional doors, and wall panels.

1.5 SUBMITTALS

A. Product Data:
   1. Product and safety data and other information for proposed products.
   2. A copy of the Manufacturer's coating application quality assurance manual.

B. Submit the product application procedure, current PDS, SDS, and a copy of the QA/QC report for surface preparation and coating application. Include complete surface preparation and cleaning procedures, as well as application equipment. Include anchor profiles, DFT, adhesion tests, temperature, humidity, holiday tests, and any other measurements taken for quality assurance and quality control during surface preparation and application.
   1. Submit quality control data verifying the coating has been inspected and is free of defects prior to the transportation of coated pipe and appurtenances from the coating facility to the Work location.
   2. Provide documentation that coating system DFT is in conformance with NSF/ANSI 61. Provide a paint schedule that lists surface preparation, coating product, location, DFT, number of coats, and cure time.

C. Field-Applied Coatings Subject to Immersion Service:
   1. Provide complete environmental condition information taken before abrasive blasting or coating. Provide environmental data at 2-hour increments if the prepared surface is not coated within 12 hours. Information provided shall include temperature, relative humidity, location description, time, date, technician name, and company.
   2. Provide the ENGINEER with data from the replica tape used to measure surface preparation and corresponding measurements in mils. Provide location reference information for each replica tape.
   3. Submit photos for the field application of coatings. Submit one photo of the field-blasted surface prior to the coating application for each area that is measured for anchor profile. Submit photos of each field-applied coat prior to the application of subsequent coats for each DFT measurement taken based on SSPC PA 2. Photos are not required for shop-applied coating application unless otherwise noted by the ENGINEER.

D. Submit the final field testing report to the ENGINEER within 2 weeks of the Substantial Completion date.

E. Samples:
   1. Initial selection: Complete fan deck, color card, or actual color chips illustrating the full range of color availability.
   2. Samples: Two, 12 inches by 12 inches, illustrating colors, glosses, and textures for each surface finishing product scheduled.

F. Quality Control Submittals:
   1. Contract closeout Submittals: Warranty.

G. Provide the ENGINEER with a schedule of systems and locations requiring color selection.

H. Warranty Documentation:
   1. Sample warranty.
   2. Warranty.

I. Supplements listed in this Section.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

B. Installer Qualifications:
   1. A minimum of 5 years of documented experience in the Work of this Section.
   2. Approved by the Manufacturer.

C. Provide finish coats compatible with substrate materials or with prime coats specified in other sections.

D. First quality preparation, painting, and finishing is required. Dirt, grit, or dust in the paint or finish; runs, sags, or drips of paint or finish; or irregularity of finish is cause for rejection. Remove rejected finishes; repair, reprime, and refinish as required to achieve a first quality finish.

E. Regulatory Requirements:
   1. Meet federal, state, and local requirements limiting the emission of VOCs.
   2. Perform surface preparation and painting in accordance with the recommendations of the following:
      a. The Paint Manufacturer's instructions, PDS.
      b. Federal, state, and local agencies having jurisdiction.

F. Coatings for Immersion Service: Under the direction of a NACE CIP Level 3.
   1. Provide name and contact information.
   2. Currently certified by NACE.

3. Attend progress meetings as required.
4. Oversee surface preparation and coating application and approve coating system.

G. Mockup:
1. Size: As required by the ENGINEER.
2. Before proceeding with Work under this Section, finish one complete space or item of each paint system and color required to show the quality of workmanship, materials, finish, texture, colors, and special details in compliance with the requirements of this Section. Provide one mockup for finishing process related spaces and items and one mockup for finishing architectural finished spaces and items.
3. Once approved, sample spaces and items shall serve as a standard for similar Work throughout the site.

H. Quality Control: Testing shall be performed by the coating applicator, third-party inspector, or as approved by the ENGINEER.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Container Label: Include the Manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Paint Materials: Store at an ambient temperature from 45°F to 90°F in a ventilated area or as required by the Manufacturer's instructions.

1.8 SITE CONDITIONS

A. Do not apply paint in temperatures or moisture conditions outside of the Manufacturer’s recommended maximum or minimum allowable.

B. Work and storage areas shall be free of dust during the application of paint finishes. Do not apply finishes in spaces with accumulated rubbish, dust, or dirt or where construction activity is present.

C. Do not perform final abrasive blast cleaning whenever the relative humidity exceeds 85%, or whenever the surface temperature is less than 5°F above the dew point of ambient air.

D. Primed surfaces shall be topcoated within 2 months or as required by the Paint Manufacturer.

E. Provide a lighting level of 80 foot-candles measured mid-height at the substrate surface.

1.9 WARRANTY

A. Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the painting and coating system and associated appurtenances, including correction, or at the option of the OWNER, removal and replacement of Work found to be defective. The OWNER shall be named as the beneficiary.

B. The CONTRACTOR and the Paint Manufacturer shall jointly furnish the warranty.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. High Performance Coatings:
1. AkzoNobel/Devoe
2. Ameron Protective Coatings
3. DuPont Chemical Company
4. Hempel Inc.
5. Keeler and Long, PPG
6. Master Builders, Inc.
7. Pittsburgh Paints
8. Plas-Chem Coatings
9. Porter-International
10. Sherwin Williams
11. Sigma Coatings, Inc.
12. Tnemec Coatings
13. Valspar Corporation
14. Wisconsin Protective Coatings

B. Paints:
1. AkzoNobel
2. Ameritone
3. Benjamin Moore Paints
4. Detroit Graphite Company
5. Fuller/O'Brien Paint Company
6. Kelly-Moore Paints
7. Kwal Paint
8. PPG Architectural Finishes, Inc.
9. Pratt and Lambert, Inc.
10. Rustoleum Corporation
11. Samuel Cabot, Inc.
12. Sherwin Williams
13. Textured Coatings of America
14. Thoro Systems

C. Specialty:
1. AkzoNobel/Ceilcote
2. AkzoNobel/Devoe High Performance Coatings
3. Darworth Company
4. Dudick, Inc.

5. Jasco Chemical Company
6. McCloskey Varnish Company
7. Olympic Paints & Stains, PPG
8. StonCor Group

D. Elastomeric Coating:
1. 3M Company
2. AkzoNobel/Polibrid
3. Futura Coatings
4. Gaco Western
5. Plas-Chem Coatings
6. Polymer Development Laboratories, Inc.
7. Technical Urethanes, Inc.
8. Thane-Coat
9. United Coatings Company

E. Fusion-Bonded Coating:
1. ABC Coating Company
2. Western Coating, Inc.

F. Testing Equipment:
1. Magnetic type DFT gauge:
   a. ElektroPhysic, MikroTest
2. Low-voltage wet sponge electrical holiday detector:
   a. Tinker and Rasor

G. Fusion-Bonded PTFE Lube:
1. 3M Company, No. 62-4621-4830-5

H. Fusion Bonded Grease Lube:
1. Amrep, RL 736
2. McMaster-Carr Co.

2.2 MATERIALS

A. General:
1. Coatings: Ready-mixed, furnished through one Manufacturer, except field-catalyzed coatings, of good flow and brushing properties, capable of drying or curing free of streaks or sags; provide field-applied primers or undercoats produced by the same Manufacturer as the finish coat(s).
2. Thinners, cleaners, driers, and other additives: As recommended by the Paint Manufacturer.
3. Application equipment: Equipment as recommended by the Paint Manufacturer.

B. Products:

Product	**Definition**
Acrylic Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
Acrylic Latex	100% acrylic, water reducible corrosion-resistant coating for light to moderate use exposures, finish as specified
Acrylic Sealer	Clear acrylic
Alkyd Enamel	Optimum quality, medium long oil, finish as specified
Bituminous Paint	Single-component, coal-tar pitch based
Epoxy, Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, non-shrinking, suitable for application to concrete and masonry. Approved for potable water contact and in accordance with NSF/ANSI 61, where required
Epoxy, High Build	Polyamide epoxy, minimum 69% volume solids, capability of 4 mils to 8 mils, DFT per coat
Epoxy, High Solids	Polyamide epoxy, 80% volume solids, minimum, suitable for immersion service
Epoxy, Non-skid (Aggregated)	Polyamide or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy, NSF	Polyamide epoxy, approved for potable water contact and in accordance with NSF/ANSI 61
Epoxy, Primer – Ferrous Metal	Polyamide, anti-corrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy, Primer – Other	Epoxy primer, high-build, as recommended by the Paint Manufacturer for specific galvanized metal, copper, or non-ferrous metal alloy to be coated
Epoxy, Water Base	Two-component, polyamide epoxy emulsion, finish as required
Fusion-Bonded Coating	100% solids, thermosetting, fusion-bonded, dry powder epoxy or polyurethane resin, suitable for the intended service
Fusion-Bonded, TFE Lube or Grease Lube	TFE, liquid coating or open gear grease

Product	Definition
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
Polyurethane, Elastomeric	100% solids, plural component, spray-applied, high build, elastomeric polyurethane coating, suitable for the intended service
Polyurethane, Enamel	Two-component, aliphatic or acrylic based polyurethane; high-gloss finish
Polyurethane, Finish	Polyurethane varnish
Rust-Inhibitive Primer	Single package steel primers with anti-corrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellent, penetrating stain
Stain, Wood	Stain luster, linseed oil
Wash Primer	Vinyl butyral acid
Zinc-Rich Primer, Organic	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 lbs metallic zinc content per gallon

C. Maintenance:
1. Extra materials: 1 gallon of each color and sheen.

2.3 FINISHES
A. Shop Coating Requirements:
1. Equipment shall be primed and finish coated in the shop by the Manufacturer and touched up in the field with identical material after installation.
2. Where the Manufacturer's standard coating is not suitable for the intended service condition, the ENGINEER may approve the use of a tie-coat to be used between the Manufacturer's standard coating and the specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by the Field Finish Coat Manufacturer. Coordinate the details of the Equipment Manufacturer's standard coating with the Paint Manufacturer.

2.4 MIXES
A. Multiple-Component Coatings:
1. Prepare using each component as packaged by the Paint Manufacturer.
2. No partial batches are permitted.
3. Do not use multiple-component coatings mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by the Paint Manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead and lead compounds.

PART 3 EXECUTION

3.1 PREPARATION
A. General: Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the most stringent recommendations of the Paint Manufacturer whose product is to be applied. The more stringent requirements shall apply. If any surface is found to be unsuitable to produce a proper finish, do not apply material until the surfaces are made satisfactory. Application of paint to any surface shall be deemed to be acceptance of that surface and full responsibility shall be borne by the CONTRACTOR.
B. Shop Abrasive Blasting:
1. Notify the ENGINEER at least 7 days prior to the start of shop-blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints.
2. Structural steel and similar items, as approved by the ENGINEER, may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop-blast cleaning.

C. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop-blasted or field-blasted and primed or coated.
D. Metal Surface Preparation:
1. Where shown on the Drawings, in accordance with the SSPC or NAPF specification.
a. Steel surfaces shall be prepared in accordance with SSPC and SSPC/NACE standards.
b. DI surfaces shall be prepared in accordance NAPF standards.
1) Prepare DI fitting surfaces in accordance with NAPF 500-03-05.
2) Prepare DI pipe surfaces in accordance with NAPF 500-03-04.
2. The words solvent cleaning, hand tool cleaning, wire brushing, and blast cleaning, or similar words of equal intent in the Contract Documents or in the Paint Manufacturer's specification, refer to the applicable SSPC or NAPF specification.
3. Where OSHA 29 CFR 1910, OSHA 29 CFR 1926, EPA 40 CFR 261, EPA AP-42, or SSPC PA Guide 10 regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. The Paint Manufacturer's recommendations for wet-blast additives and first coat application shall apply.
4. Hand tool clean areas that cannot be cleaned by power tool cleaning.

5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Welds and adjacent areas:
    a. Prepare such that there is the following:
        1) No undercutting or reverse ridges on weld bead.
        2) No weld spatter on or adjacent to weld or any area to be painted.
        3) No sharp peaks or ridges along weld bead.
    b. Grind embedded pieces of electrode or wire flush with the adjacent surface of weld bead.
7. Pre-blast cleaning requirements:
    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing. Waterjetting in accordance with SSPC/NACE SP WJ-1/NACE WJ-1.
    c. Clean small isolated areas as above or solvent clean with suitable solvent and a clean cloth.
8. Blast cleaning requirements:
    a. Type of equipment and speed of travel: Design to obtain a specified degree of cleanliness; minimum surface preparation is as specified herein and takes precedence over the Paint Manufacturer's recommendations.
    b. Select the type and size of abrasive to produce a surface profile that meets the Paint Manufacturer's recommendations.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
9. Post-blast cleaning and other cleaning requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning (no oil or water vapor) or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same working day they are blasted. Re-blast surfaces that have begun to rust prior to painting.

E. Concrete Surface Preparation:
1. Do not begin until 30 days after concrete has been placed.
2. In accordance with SSPC/NACE SP 13/NACE No.6 and ASTM D 4258.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Verify the required acid-alkali balance has been achieved.
5. Brush-off blast concrete surface to remove loose concrete and laitance and provide a tooth for binding. Upon approval by the ENGINEER, the surface may be cleaned by the acid etching method. Approval is subject to producing a desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
6. Secure the Paint Manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
7. Concrete wall surface preparation:
    a. Patch tie holes.
    b. Sack-rub with grout to fill voids.
8. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic Surface Preparation:
1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for the coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without removing excess material.
3. FRP equipment with an integral colored gel coat does not require painting, provided the color is as selected.

G. Masonry Surface Preparation:
1. Complete and cure masonry construction for 14 days or more before starting surface preparation Work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
    a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    b. Brush-off blasting.
    c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and dry prior to painting, unless otherwise required for proper adhesion.
6. Masonry surfaces to be painted: Uniform texture and free of surface imperfections that would impair the intended finished appearance.
7. Masonry surfaces to be clear coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:
1. Replace damaged wood surfaces or repair in a manner acceptable to the ENGINEER prior to the start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.

4. Filler:
    a. Synthetic-based wood putty approved by the Paint Manufacturer for the paint system.
    b. For natural finishes, the color of wood putty shall match the color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with the surrounding surface and sand smooth.
    d. Apply putty before or after the prime coat depending on compatibility and the Putty Manufacturer's recommendations.
    e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

I. Gypsum Board Surface Preparation:
1. Allow joint treatment to thoroughly dry. Lightly sand joint treatments and topping compounds to produce a uniform, smooth surface. Wipe or brush free of sanding dust. Prime exposed metal corner beads and other accessories with galvanized metal primer.
2. Fill minor defects with filler compound. Spot prime defects after repair.

J. Plaster Surface Preparation:
1. Fill hairline cracks, small holes, and imperfections with latex patching plaster. Finish smooth and flush with adjacent surfaces.
2. Wash and neutralize high alkali surfaces.

K. Surface Preparation for Existing Painted Surfaces to be Repainted:
1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool in accordance with SSPC SP 2 or SSPC SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of the specified primer to bare areas, overlapping the prepared existing coating.
5. Apply one full finish coat of the specified primer to the entire surface.
6. If an aged, plural-component material is to be top coated, contact the Paint Manufacturer for additional surface preparation requirements.
7. Application of cosmetic coat:
    a. Verify that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with the paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from the ENGINEER.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, and procedures shall meet the requirements of the SSPC.

L. Non-Ferrous Metal Preparation for Coating: The non-ferrous surface shall be coated within 2 days if it is stored in an environmentally controlled space to avoid coating over the zinc oxide and zinc hydroxide layer that forms. After 2 days, the surface shall be sweep blasted and the coating applied within 1 hour of the blasting. The blasting shall be performed in accordance with ASTM D 6386 and SSPC SP 16, including:
1. Reduced blast pressure, 40 psi or less.
2. Reduced blasting dwell time.
3. Increased distance of blast nozzle from the surface, 18 inches to 24 inches.
4. Reduced blast angle, 30 degrees to 60 degrees rather than 90 degrees.
5. A softer blast media: Aluminum/magnesium silicate, corncobs, walnut shells, corundum, limestone, or mineral sands with a Mohr's hardness level 5 or less.
6. No resurfacing with sanders or grinders.
7. If the item is stored outside after galvanizing, the surface preparation shall be performed as weathering has begun.
8. A minimum surface profile of 0.75 mil on the bare metal surface is required.
9. Intact coatings are required to be roughened to the degree specified for the coating to be used.

M. Provide the ENGINEER a minimum of 7 days advance notice to the start of field surface preparation Work and coating application Work.

N. Schedule an inspection of cleaned surfaces and all coats prior to successive coat in advance with the ENGINEER.

O. Factory-Finished Items:
1. Schedule an inspection with the ENGINEER before repairing damage to factory-finished items delivered to the site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by the Paint Manufacturer. Carefully blend repaired areas into the original finish. If required to match colors, provide a full finish coat in the field.

P. Measure the moisture content of surfaces using an electronic moisture meter. Do not apply paint unless the moisture content of surfaces is below the following maximums:
1. Gypsum board and plaster: 12%.
2. Masonry and concrete: 12%.
3. Wood: 15%, tested in accordance with ASTM D 4442.
4. Concrete floors: 8%.

Q. Colors:
1. Color code non-submerged metal piping; paint fittings and valves the same color as the pipe.
2. New work: Color coding in accordance with the piping color code schedule.
3. Repair work: Match existing color.
4. Proprietary identification of colors is for identification only; the selected Manufacturer may supply matches.

5. Safety colors shall be in accordance with ANSI/NEMA Z535.1.
6. Other colors:
    a. Paint equipment and piping one color as selected. Equipment includes the machinery or vessel itself and the structural supports and fasteners and attached electrical conduits.
    b. Paint electrical enclosures ANSI 61 gray unless otherwise specified by the ENGINEER.
    c. Paint non-submerged portions of equipment the same color as the piping it serves, except as itemized below:
        1) Dangerous parts of equipment and machinery: OSHA orange.
        2) Fire protection equipment and apparatus: OSHA red.
        3) Radiation hazards: OSHA purple.
        4) Physical hazards in normal operating area including striking against, stumbling, falling, tripping, and "caught in between." Energy lockout devices including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA yellow.

3.2 APPLICATION

A. General:
1. Paint new interior and exterior masonry, concrete, and metal surfaces, except as specified otherwise. Do not paint exterior concrete surfaces unless specified otherwise.
2. Resinous floor coatings shall be applied as specified in SECTION 09 67 16.
3. Immersion coatings: Apply coatings to exposed metal subject to immersion service, including but not limited to internal vessel and pipe surfaces, nozzle bores, and carbon steel internals, unless otherwise specified. Apply epoxy and polyurethane coatings for immersion service as specified in SECTION 09 97 13.01 and SECTION 09 97 13.02.
    a. Coatings subject to immersion shall be applied by an SSPC QP 1 certified applicator and have a minimum surface preparation of SSPC SP 10/NACE No. 2.
    b. Obtain a full cure for completed system. Consult the Paint Manufacturer's instructions for these requirements. Do not immerse coating until completion of the curing cycle. Environmental conditions recommended by the Manufacturer shall be maintained throughout the duration of the curing cycle.
4. Apply paint in accordance with the Contract Documents and the Paint Manufacturer's recommendations. The more stringent requirements shall apply. Allow sufficient time between coats to ensure thorough drying or curing of previously applied paint.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying the next coat.
6. Fusion-bonded coatings method application: Electrostatic, fluidized bed, or flocking.
7. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
8. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
9. Follow the Manufacturer's recommended storage procedures. Do not store coatings in direct sunlight.
10. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing the required number of coats have been applied.

B. Workmanship:
1. If surfaces are not in proper shape for coating application, repair, rebuild, or refinish before proceeding with the Work. Assume responsibility for inadequate Work caused by improper surface preparation. The application of the first coat does not relieve the responsibility for the base. Do not apply any coats on damp or wet surfaces and in no case until the preceding coat has cured. Avoid contamination or damage to prepared or intercoat surfaces. Clean and re-repair as required.
2. Application: Spread materials evenly without runs or sags and thoroughly brush out. Provide a finish that is free of abrasions, dirt, or other debris and uniform in color and appearance.
    a. The number of coats specified is the minimum to be applied. Apply additional coats when undercoats, stains, or other conditions show through the final finish coat until the paint film is of uniform finish, color, and appearance.
3. Roller application: Use a fine nap roller to roll and backroll so a nearly flat or orange peel texture is achieved. Do not use a roller application on metal or wood surfaces. Coating application shall be uniform in color, texture, and shade. Aesthetic defects shall be cause for rejection.
4. Spray application: Apply with airless or air pressure spray equipment as recommended by the Paint Manufacturer for the particular product. Apply each coat in a uniform manner to provide the equivalent thickness of brush coats. Do not double back to build up the film thickness of two coats in one pass.
5. Brush application: Brush paint with equipment and the technique required to achieve a flat and smooth surface without brush marks. Brush out and work paint onto the surfaces in a uniform, even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, and other surface imperfections are not acceptable.
6. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing only after finishing has completely dried and hardened. Use workmen skilled in the installation of the items removed; install in a manner that does not void warranties.

C. Shop-Primed and Factory-Finished Surfaces:
1. Schedule an inspection with the ENGINEER before shop priming or top coating factory-finished items are delivered to the site.
2. Prepare surfaces and spot prime using the specified primer.
3. Apply a mist coat of primer, 1 mil DFT.
4. After welding, prepare and prime holdback areas as required for the paint system. Apply primer in accordance with the Manufacturer's instructions.

D. Manufacturer-Applied Paint Systems:
   1. Repair abraded areas on factory-finished items as recommended by the Manufacturer.
   2. Carefully blend repaired areas into the original finish.
   3. Fusion-bonded coatings: Provide appropriate liquid repair kits for field use.
E. Galvanized Metal, Copper, and Non-Ferrous Metal Alloys:
   1. Concealed galvanized, copper, and non-ferrous metal alloy surfaces behind building panels or walls do not require painting.
   2. Prepare the surface and apply primer in accordance with the System No. 10 requirements.
   3. Apply intermediate and finish coats of the coating system appropriate for the exposure.
F. Porous Surfaces, such as Concrete and Masonry:
   1. Filler/surfacer: Use the Paint Manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
   2. Prime coat: May be thinned to provide maximum penetration and adhesion.
      a. Type and amount of thinning: Determined by the Paint Manufacturer and dependent on surface density and type of coating.
   3. Surface specified to receive water base coating: Damp but free of running water, just prior to the application of coating.
G. Film Thickness and Coverage:
   1. Number of coats:
      a. The minimum required without regard to coating thickness.
      b. Additional coats may be required to obtain the minimum required paint thickness depending on method of application, differences in the Manufacturer's products, and atmospheric conditions.
   2. Application thickness:
      a. Do not exceed the Manufacturer's recommendations.
      b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
   3. Visually inspect concrete, masonry, non-ferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
   4. Give particular attention to edges, angles, flanges, and other similar areas where insufficient film thicknesses are likely to be present and ensure proper DFT in these areas.
   5. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.
H. Factory-Applied Priming:
   1. Priming or priming and finishing of certain surfaces may be specified to be factory-applied or shop-applied by fabricators.
   2. Carefully examine the Contract Documents for priming or finishing Work installed by other trades to avoid duplications or omissions.

3.3 PROTECTION
A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and the painting process.
D. Mask openings in motors to prevent paint and other materials from entering.
E. Protect surfaces from overspray that are adjacent to or downwind of the Work area.

3.4 QUALITY CONTROL
A. Thickness Testing:
   1. Measure coating thickness specified in mils with magnetic type, DFT gauge, in accordance with SSPC PA 2.
   2. Check each coat for correct DFT.
   3. Paint and coatings shall be cured to touch prior to DFT testing.
B. Testing for Epoxy and Polyurethane Coatings:
   1. Surface preparation testing:
      a. Measure prepared surface profile using magnetic type gauge or replica tape in accordance with NACE SP0287.
      b. Verify surface is free of debris and particulate prior to coating application using clear tape.
   2. Continuity testing:
      a. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low-voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
      b. After repaired and recoated areas have dried sufficiently, retest each repaired area.
      c. Final tests may also be conducted by the ENGINEER.
C. Inspection: Leave staging and lighting in place until the ENGINEER has inspected the surface or coating. Replace staging removed prior to approval by the ENGINEER. Provide additional staging and lighting as requested by the ENGINEER.
D. Unsatisfactory Application:
   1. If an item has an improper finish color or insufficient film thickness, clean the surface and topcoat with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the Paint Manufacturer.
   2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.

3. Repair defects in accordance with the written recommendations of the Paint Manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:
   1. Feather edges and repair in accordance with the recommendations of the Paint Manufacturer.
   2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on the extent of repair and appearance, a finish sanding and topcoat may be required.
   3. Apply finish coats, including touch up and damage-repair coats, in a manner that will present a uniform texture and color-matched appearance.

F. Manufacturer's Services:
   1. The Paint Manufacturer's Representative shall be present at the site:
      a. On the first day of the application of any coating system.
      b. A minimum of two additional site inspection visits, to provide the Manufacturer's certificate of proper installation.
      c. As required to resolve field problems attributable to or associated with the Manufacturer's product.
      d. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.5 CLEANING

A. Brush-off Blast Cleaning:
   1. The equipment, procedure, and degree of cleaning in accordance with SSPC/NACE SP 7/NACE No. 4 or SSPC SP 16.
   2. Abrasive: Wet or dry blasting sand, grit, or nutshell.
   3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that the surface is cleaned without pitting, chipping, or other damage.
   4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
   5. The ENGINEER will approve the trial blast cleaned area and, if acceptable, use the area as a representative sample of surface preparation.
   6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:
   1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10% solution of HCl.
   2. Application:
      a. Rate: 2 gallons/100 sf.
      b. Work acid solution into the surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
      c. Acid will react vigorously for a few minutes during which time brushing shall be continued.
      d. After bubbling subsides, in approximately 10 minutes, hose down the remaining slurry with high-pressure clean water.
      e. Rinse immediately to avoid the formation of salts on the surface that are difficult to remove.
      f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
   3. Ensure surface is completely dry before the application of paint.
   4. Apply acid etching to obtain a grit sandpaper surface profile. If the surface is not achieved, repeat the treatment.

C. Solvent Cleaning:
   1. In accordance with SSPC SP 1.
   2. Consists of the removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.

D. Power Tool Cleaning: In accordance with SSPC SP 11. Use of an MBX Bristle Blaster is required for power tool cleaning in buried, submerged, or immersion environments.

E. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

F. Upon the Substantial Completion date, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

G. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave the entire job clean.

3.6 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the ENGINEER before starting the Work.

B. Stripe coat edges and corners for any surface subject to a highly corrosive or submerged environment.

C. System No. 1, Submerged Metal – Potable: Apply epoxy or polyurethane coatings as specified in SECTION 09 97 13.01 and SECTION 09 97 13.02.

D. System No. 2, Submerged Metal – Recycle Water: Apply epoxy or polyurethane coatings as specified in SECTION 09 97 13.01 and SECTION 09 97 13.02.

E. System No. 4, Interior and Exterior Exposed Metal – Highly Corrosive: Structures including, but not limited to, vaults, manholes, reservoirs, tank interiors, and other areas where metal is exposed to high humidity and the possibility of dripping moisture or immersion service. Also includes areas in contact with fumes from chlorine gas, hydrogen sulfide gas, or other corrosive gasses.

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Liquid-Epoxy, Primer	1 coat, 4 mils to 10 mils, DFT
	Aliphatic Polyurethane	1 to 2 coats, 3 mils to 6 mils, DFT

F. System No. 5, Interior and Exterior Exposed Metal – Mildly Corrosive: Structures including, but not limited to, above ground buildings, predominantly dry interiors, and other surfaces that will be subjected to minimal or no dripping. Relative humidity exceeding 85% during normal operation or presence of corrosive gasses are considered a highly corrosive environment.

Surface Preparation	Paint Material	Minimum Coats, Cover
Steel: SSPC SP 10/NACE No. 2 DI: NAPF 500-03-04	Liquid-Epoxy, Primer	1 coat, 2.5 mils to 8 mils, DFT
	Aliphatic Polyurethane	1 to 2 coats, 3 mils to 6 mils, DFT

G. System No. 6, Interior and Exterior Exposed Metal – Atmospheric: Structures including, but not limited to, dry building interiors, electrical rooms, office spaces, or other surfaces that will not be subjected to humidity, corrosive gasses, or dripping moisture.

Surface Preparation	Paint Material	Minimum Coats, Cover
Steel: Commercial Blast Cleaning (SP 6/NACE No. 3) DI: NAPF 500-03-04	Rust-Inhibitive Primer	1 coat, 2.5 mils, DFT
	Alkyd Enamel	2 coats, 4 mils, DFT

H. System No. 7, Interior and Exterior Metal – Denver International Airport:
1. Vault hatch lids.
2. Colors, based on the Pantone Matching System:
   a. Orange: Pantone 138C.
   b. Blue: Pantone 292C.
3. Color shall be achieved in the top coat. Base color may be of any color.
4. Apply blue to the entire exterior surface of the hatch, except for the trim strip.
5. Apply a 4 inch wide orange trim stripe to the perimeter of the hatch.

Surface Preparation	Paint Material	Minimum Coats, Cover
Steel: SSPC SP 10/NACE No. 2 DI: NAPF 500-03-04	Liquid-Epoxy, Primer	1 coat, 16.0 mils, DFT
	Aliphatic Polyurethane	1 to 2 coats, 3 mils to 6 mils, DFT

I. System No. 10, Galvanized Metal, Copper, and Non-ferrous Metal Alloy Conditioning:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2) or Power Tool (SP 3) or Brush-Off Blast (SP 16)	Wash Primer or Paint Manufacturer's Recommendation	1 coat, 0.4 mils, DFT

J. System No. 11, Galvanized Metal Repair:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7/NACE No. 4)	Zinc-Rich Primer, Organic	1 coat, 3 mils, DFT

K. System No. 23, Chemical-Resistant Wall – Concrete:

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Concrete Surface Preparation	Liquid-Epoxy, Filler/Surfacer	1 coat, as required to fill voids
	Liquid-Epoxy, High Build (Gloss)	1 coat, 160 sfpg

L. System No. 24, Plastic and Exposed FRP:

Surface Preparation	Paint Material	Minimum Coats, Cover
In accordance with Plastic and FRP Surface Preparation	Polyurethane, Enamel	1 coat, 320 sfpgpc

M. System No. 27, Aluminum and Dissimilar Metal Insulation:

Surface Preparation	Paint Material	Minimum Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with the Manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 mils, DFT

N. System No. 29, Fusion-Bonded Coating, Atmospheric: Includes buried hardware, harness rings, BSTCs, fittings, and other appurtenances.

Surface Preparation	Paint Material	Minimum Coats, Cover
Steel: SSPC SP 10/NACE No. 2 DI: NAPF 500-03-04	Fusion-Bonded Epoxy (AWWA C550)	1 or 2 coats, 10 mils, DFT

O. System No. 30, Fusion-Bonded Coating, Submerged or Buried: Includes buried hardware, harness rings, BSTC's, fittings, and other appurtenances.

Surface Preparation	Paint Material	Minimum Coats, Cover
Steel: SSPC SP 10/NACE No. 2 DI: NAPF 500-03-04	Fusion-Bonded Epoxy (AWWA C550)	1 or 2 coats, 20 mils, DFT

P. System No. 31, Fusion-Bonded, Steel Dowel Coating:

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2 or SSPC SP 8	Fusion-Bonded Epoxy (AWWA C550)	1 or 2 coats, 7 mils, DFT
TFE Lube, Shop-Applied; Grease Lube Alternative, Field-Applied Just Prior to Installation	Fusion-Bonded Epoxy (AWWA C550), TFE Lube or Grease Lube	1 coat, as required

Q. System No. 32, Three Part Exterior Exposed Steel – Atmospheric, UV Exposure:
1. Apply zinc, polyurethane, and fluoropolymer coatings as specified in SECTION 09 97 13.01 and SECTION 09 97 13.02 for PART I, GENERAL and PART 3, EXECUTION requirements.
2. Apply products at thicknesses noted in the paint system.

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Organic Zinc-Rich, Primer	2.5 mils to 4.0 mils, DFT
	Aliphatic Acrylic Polyurethane, Intermediate	3.0 mils to 6.0 mils, DFT
	Fluoropolymer, Topcoat	2.0 mils to 3.0 mils, DFT

R. System No. 33, Thermal Insulating Coating: Structures subjected to heavy condensation and other severe exposure conditions approved by the ENGINEER.

Surface Preparation	Paint Material	Minimum Coats, Cover
SSPC SP 10/NACE No. 2	Liquid-Epoxy, Primer	4 mils to 8 mils, DFT
	Tnemec Series 971 Aerolon Acrylic, Intermediate	30 mils to 50 mils, DFT
	Aliphatic Acrylic Polyurethane or Fluoropolymer, Topcoat	3 mils to 5 mils, DFT

S. System No. 34, Valve Coatings and Linings:
1. Valves for Water Utility Piping:
a. Machined flange faces shall be shop-coated with a rust-preventive compound, they shall not be coated with liquid-epoxy or fusion bonded epoxy.
b. Provide 16 mils, DFT of coating on the exterior of buried or submerged valves.
1) Valves in atmospheric service:

Surface Preparation	Paint Material	Minimum Coats, Cover
(Steel) SSPC SP 10/NACE No. 2	Fusion Bonded Epoxy (AWWA C550)	10 mils, DFT
(DI) NAPF 500-03-04	or Liquid-Epoxy	

2) Valves in buried/submerged service:

Surface Preparation	Paint Material	Minimum Coats, Cover
(Steel) SSPC SP 10/NACE No. 2	Fusion Bonded Epoxy (AWWA C550)	Lining: 10 mils, DFT
(DI) NAPF 500-03-04	or Liquid-Epoxy	Coating: 16 mils, DFT

T. System No. 35, Fire Hydrant Coating:
1. Dry-barrel fire hydrants:

Surface Preparation	Paint Material	Minimum Coats, Cover
NAPF 500-03-04	Primer	3 mils, DFT
	Polyurethane, Enamel	10 mils, DFT

3.7 SUPPLEMENTS
A. Supplement A – Piping Color Code Schedule (PCCS)
B. Supplement B – Paint System Data Sheet (PSDS)
C. Supplement C – Paint Product Data Sheet (PPDS)

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A – PIPING COLOR CODE SCHEDULE

Legend	Pipe System	Color	Pantone Color Chart [1]	Pipe Banding Color
AHP	Air, High Pressure	Dark Green	Pantone 5467	Orange Band
AI	Air Instrument	None	None	None
ALP	Air, Low Pressure	Dark Green	Pantone 5467	Yellow band
AVD	Air Valve Drain	Black	Pantone 419	None
ALUM	Aluminum Sulfate	Federal Safety Orange	Pantone 166	Blue Band
POA	Anionic Polymer	Federal Safety Orange	Pantone 166	Violet Band
NH_3	Aqueous Ammonia	White	Pantone 427	NONE
BWA	Backwash Air	Dark Green	Pantone 5467	Blue Band
BWS	Backwash Supply	Safety Purple	Pantone 2665	Blue Band
BWW	Backwash Waste	Light Brown	Pantone 479	None
AA	Aeration Air	Safety Green	Pantone 348	None
CA	Carbon	Black	Pantone 419	Red Band
CO_2	Carbon Dioxide	Federal Safety Yellow	Pantone 116	Violet Band
PC	Cationic Polymer	Federal Safety Orange	Pantone 166	White Band
CD	Chemical Drain	Federal Safety Yellow	Pantone 116	Black Band
CHWR	Chilled Water Return	Light Blue	Pantone 290	White Band
CHWS	Chilled Water Supply	Light Blue	Pantone 290	None
CG	Chlorine Gas, Pressured	Federal Safety Yellow	Pantone 116	None
CGV	Chlorine Gas, Vacuum	Federal Safety Yellow	Pantone 116	None
CS	Chlorine Solution	Federal Safety Yellow	Pantone 116	None
CSHP	Chlorine Solution, High Pressure	Federal Safety Yellow	Pantone 116	None
CL	Chlorine Liquid, Pressured	Federal Safety Yellow	Pantone 116	None
CLD	Chlorine Dioxide	Federal Safety Yellow	Pantone 116	Violet Band
CLR	Clarified Water	Aqua	Pantone 306	None
CND	Condensate Drain	Dark Grey	Pantone 445	None
DSL	Decant Sludge Line	Light Brown	Pantone 479	None
DIW	Deionized Water	None	None	None
DHW	Domestic Hot Water	Dark Blue	Pantone 301	Red Band

Legend	Pipe System	Color	Pantone Color Chart [1]	Pipe Banding Color
DHWR	Domestic Hot Water Recirculation	Dark Blue	Pantone 301	White Band
DR	Drain	Black	Pantone 419	None
DS	Drain, Sanitary	Dark Grey	Pantone 445	None
DWS	Drain, Sanitary – Double Wall	Dark Grey	Pantone 445	None
LD	Dry Lime			
ELECT	Electrical Conduit	Dark Grey	Pantone 431	None
HV	Electrical, High Voltage	Light Grey	Pantone 5435	
LV	Electrical, Low Voltage	Light Grey	Pantone 5435	
$FECL_3$	Ferric Chloride	Federal Safety Orange	Pantone 166	
FS	Ferric Sulfate	Federal Safety Orange	Pantone 166	Black Band
FST	Ferric Sulfate (Tanks Only)	Reddish Brown		Black Band
FE	Filter Effluent	Medium Blue	Pantone 292	None
FE	Filter Effluent (Recycled Water)	Purple	Pantone 2577 U [2]	Yellow Band
FH	Fire Hydrant	Safety Yellow	Pantone 116	None
FI	Filter Influent	Aqua	Pantone 306	None
FTW	Filter to Waste	Light Brown	Pantone 479	Yellow Band
FW	Finished Water	Dark Blue	Pantone 301	Violet Band
FA	Fire Alarm	Red	Pantone 484	None
FS	Fire Sprinkler	Dark Blue	Pantone 301	Red Band
FSI	Flocculation/Sedimentation Influent	Olive Green	Pantone 357	Orange Band
FL	Fluoride, Dry Powder			
FLS	Fluoride Solution	Light Blue	Pantone 290	Red Band
GAS	Gasoline			
HTWR	Heating Water Return (HVAC)			
HTWS	Heating Water Supply (HVAC)			
HPT	High Pressure Return (Condensate)			
HPS	High Pressure Steam			
HYDOL	Hydraulic Oil Return	Ivory		None

Legend	Pipe System	Color	Pantone Color Chart [1]	Pipe Banding Color
HYDOS	Hydraulic Oil Supply	Ivory		None
IRR	Irrigation (Potable Water)	Dark Blue	Pantone 301	None
IRR	Irrigation (Recycle Water)	Purple	Pantone 2577 U[2]	None
LD	Lime, Dry Powder			
LS	Lime Slurry	Light Green	Pantone 331	None
LOX	Liquid Oxygen			
LPR	Low Pressure Return (Condensate)			
LPS	Low Pressure Steam			
MPR	Medium Pressure Return (Condensate)			
MPS	Medium Pressure Steam			
G	Natural Gas	Federal Safety Green	Pantone 348	None
N_2	Nitrogen Gas	Light Green	Pantone 331	Red Band
PON	Non-Ionic Polymer	Federal Safety Orange	Pantone 166	Green Band
O	Oxygen			
ORD	Overflow Roof Drain	Black	Pantone 419	None
OVFL	Overflow	Black	Pantone 419	None
O_3	Ozone	Federal Safety Yellow	Pantone 116	Orange Band
POTW	Potable Water	Dark Blue	Pantone 301	None
PP	Potassium Permanganate	Violet		None
PPS	Potassium Permanganate Solution	Violet		None
PS	Pressure Sewer	Dark Grey	Pantone 445	Red Band
P	Propane Gas	Federal Safety Green	Pantone 348	Red Band
RW	Raw Water	Olive Green (John Deere)	Pantone 357	None
RW	Raw Water (Recycling Source)	Dark Green	Pantone 5535	None
R	Recycled Water	Purple	Pantone 2577 U[2]	None
RD	Roof Drain	Black	Pantone 419	None
SS	Sanitary Sewer (Gravity)	Dark Grey	Pantone 445	None
SAMP	Sample Water	Medium Green	Pantone 363	None

Legend	Pipe System	Color	Pantone Color Chart [1]	Pipe Banding Color
SVW	Service Water (Recycled Water)	Purple	Pantone 2577 U[2]	None
SVW/HP	Service Water, High Pressure	Medium Blue	Pantone 292	Red Band
SVW/LP	Service Water, Low Pressure	Light Blue	Pantone 290	Blue Band
SETW	Settled Water	Aqua	Pantone 306	None
SASH	Soda Ash	Light Green	Pantone 331	Orange
NA	Sodium Hydroxide	Federal Safety Yellow	Pantone 116	Green Band
SD	Storm Drain	Grey	Pantone 444	None
SFA	Sulfuric Acid	Federal Safety Yellow	Pantone 116	Red Band
SPD	Sump Pump Discharge	Dark Grey	Pantone 444	None
SURW	Surface Wash			
TSL	Thickened Sludge Line	Dark Brown	Pantone 732	None
USL	Unthickened Sludge Line	Dark Brown	Pantone 732	None
VAC	Vacuum	Federal Safety Green	Pantone 348	Black Band
V	Vent	Pump Grey	Pantone 5435	Red Band
VS	Vent, Sanitary	Pump Grey	Pantone 5435	None
VTR	Vent to Roof	Pump Grey	Pantone 5435	Black Band
XE	Xcel Energy			
PWFM	Waste Force Drain	Dark Grey	Pantone 445	None

Notes:

[1] Pantone paint color reference is used solely to facilitate color selection. Other Manufacturers listed in the Section are acceptable with similar matching colors.

[2] Pantone 2577U color reference is manufactured and used solely to facilitate color selection. Other Manufacturers listed in the Section are acceptable with similar matching colors.

In accordance with EIA 359 for items for specifically covered in the PCCS.

SUPPLEMENT B – PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system. Include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Minimum Coats, Coverage**

INTENTIONALLY BLANK

SUPPLEMENT C – PAINT PRODUCT DATA SHEET

Complete and attach the Manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide the Manufacturer's recommendations for the following parameters at temperature (°F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Minimum Recoat Time			
Maximum Recoat Time			

Provide the Manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: minimum: _____ maximum: _____

Surface Temperature Limitations: minimum: _____ maximum: _____

Surface Profile Requirements: minimum: _____ maximum: _____

INTENTIONALLY BLANK

SECTION 09 91 00
ARCHITECTURAL PAINTING AND COATING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for architectural painting and coating.
- B. Related Sections:
  1. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. D 523 – Standard Test Method for Specular Gloss
- B. Environmental Protection Agency (EPA):
  1. 40 CFR 261 – Identification and Listing of Hazardous Waste
  2. AP-42 – Compilation of Air Pollutant Emission Factors – Volume I: Stationary Point and Area Sources, Chapter 13.2.6 – Abrasive Blasting
- C. International Concrete Repair Institute (ICRI):
  1. 310.2R – Selecting and Specifying Concrete Surface Preparation
- D. Master Painters Institute LLC (MPI):
  1. Approved Products List
  2. Architectural Painting Manual
- E. Occupational Safety and Health Administration (OSHA):
  1. 29 CFR 1910 – Occupational Safety and Health Standards
  2. 29 CFR 1926 – Safety and Health Regulations for Construction
- F. The Society for Protective Coatings (SSPC):
  1. PA Guide 10 – Contractor ESH Requirements
  2. SP 1 – Solvent Cleaning
  3. SP 8 – Pickling
  4. SP 11 – Bare Metal Power Tool Cleaning
  5. SP 16 – Brush-Off Blast Cleaning Non-Ferrous Metals
- G. The Society for Protective Coatings/NACE International (SSPC/NACE):
  1. SSPC SP 6/NACE No. 3 – Commercial Blast Cleaning
  2. SSPC SP 7/NACE No. 4 – Brush-Off Blast Cleaning
  3. SSPC SP 13/NACE No. 6 – Surface Preparation of Concrete
  4. SSPC SP WJ-1/NACE WJ-1 – Waterjetting to Bare Substrate
- H. South Coast Air Quality Management District (SCAQMD):
  1. Rule 1113 – Architectural Coatings

1.3 DEFINITIONS
- A. Coverage: Total minimum DFT in mils or sfpg.
- B. Paint: The term paint, as used herein, means coating systems materials including primers, sealers, fillers, emulsions, enamels, epoxy, stains, lacquers, varnishes, and other applied materials, whether used in prime coats, intermediate coats, or finish coats.
- C. Gloss Levels: Paint gloss levels specified herein are based on the following:
  1. MPI Gloss Level 1: Not more than 5 units at 60° and 10 units at 85°, in accordance with ASTM D 523.
  2. MPI Gloss Level 2: Not more than 10 units at 60° and 10 to 35 units at 85°, in accordance with ASTM D 523.
  3. MPI Gloss Level 3: 10 to 25 units at 60° and 10 to 35 units at 85°, in accordance with ASTM D 523.
  4. MPI Gloss Level 4: 20 to 35 units at 60° and not less than 35 units at 85°, in accordance with ASTM D 523.
  5. MPI Gloss Level 5: 35 to 70 units at 60°, in accordance with ASTM D 523.
  6. MPI Gloss Level 6: 70 to 85 units at 60°, in accordance with ASTM D 523.
  7. MPI Gloss Level 7: More than 85 units at 60°, in accordance with ASTM D 523.

1.4 SEQUENCING AND SCHEDULING
- A. Work Not Included:
  1. Surfaces in concealed or inaccessible areas such as furred spaces, foundation spaces, pipe or duct chases, shafts, or utility tunnels.
  2. Surfaces of anodized or prefinished aluminum, SST, bronze, brass, and chromium plate.
  3. Moving parts of operating equipment, mechanical or electrical moving parts, linkages, sensing devices, and motor shafts.
  4. Buried concrete surfaces.
  5. Nonmetallic materials such as glass and porcelain.
  6. Prefinished electrical items such as motors, motor control centers, switchboards, switchgear, panelboards, transformers, and disconnect switches.
  7. Prefinished architectural items such as acoustical tile, cabinets, building louvers, overhead coiling doors, sectional doors, and wall panels.
  8. FRP equipment with an integral colored gel coat does not require painting, provided the color is as selected.

1.5 SUBMITTALS
- A. Product Data:
  1. For each type of product. Include preparation requirements and application instructions.
     a. Include a printout of the current MPI Approved Products List for each product category specified, with the proposed product highlighted.

b. Indicate VOC content.

B. Provide a paint schedule that lists surface preparation, coating product, location, DFT, number of coats, and cure time.

C. Samples:
1. Initial selection: Complete fan deck, color card, or actual color chips illustrating the full range of color availability.
2. Samples for verification: For each type of paint system and in each color and gloss of topcoat.
a. Submit samples on rigid backing, 8 1/2 inches by 11 inches.
b. Label each coat of each sample.
c. Label each sample for location and application area.

D. Quality Control Submittals: Contract closeout submittals: Warranty.

E. Provide the ENGINEER with a schedule of systems and locations requiring color selection.

F. Supplements listed in this Section.

G. Spare Parts:
1. Extra materials: 1 gallon of each color and sheen.
2. Colors: Formulate paints with colorants free of lead and lead compounds.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.

B. Installer Qualifications:
1. A minimum of 5 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.

C. MPI Standards:
1. Products: In accordance with MPI standards indicated and listed in the MPI Approved Products List.
2. Preparation and workmanship: In accordance with requirements in the MPI Architectural Painting Manual for products and paint systems indicated.

D. Provide finish coats compatible with substrate materials or with prime coats specified in other Sections.

E. First quality preparation, painting, and finishing is required. Dirt, grit, or dust in the paint or finish; runs, sags, or drips of paint or finish; or irregularity of finish is cause for rejection. Remove rejected finishes; repair, re-prime, and refinish as required to achieve a first quality finish.

F. Regulatory Requirements:
1. Meet federal, state, and local requirements limiting the emission of VOCs.
2. Perform surface preparation and painting in accordance with the recommendations of the following:
a. The Paint Manufacturer’s instructions.
b. Federal, state, and local agencies having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Container label: Include the Manufacturer's name, type of paint, brand name, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

B. Paint materials: Store at an ambient temperature from 45°F to 90°F in a ventilated area or in accordance with the Manufacturer's instructions.

1.8 SITE CONDITIONS

A. Do not apply paint in temperatures or moisture conditions outside of the Manufacturer’s recommended maximum or minimum allowable.

B. Work and storage areas shall be free of dust during the application of paint finishes. Do not apply finishes in spaces with accumulated rubbish, dust, or dirt or where construction activity is present.

C. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50°F and 95° F.

D. Do not apply paints when relative humidity exceeds 85%; at temperatures less than 5°F above the dew point; or to damp or wet surfaces.

1.9 WARRANTY

A. Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the painting and coating system and associated appurtenances, including correction, or at the option of the OWNER, removal and replacement of Work found to be defective. The OWNER will be named as the beneficiary.

B. The CONTRACTOR and the Paint Manufacturer shall jointly furnish the warranty.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Paints:
1. AkzoNobel/Dulux
2. Benjamin Moore Paints
3. PPG Architectural Finishes, Inc.
4. Sherwin Williams

B. Products: Subject to compliance with requirements, provide product listed in the interior painting schedule for the paint category indicated.

2.2 MATERIALS

A. General:
1. Material compatibility:
a. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by Manufacturer, based on testing and field experience.

b. For each coat in a paint system, products shall be recommended in writing by the Topcoat Manufacturers for use in paint system and on substrate indicated.

B. VOC Content: Products shall be in accordance with the VOC limits of the AHJs and, for interior paints and coatings applied at Project site.

C. Maintenance:
1. Extra materials: 1 gallon of each color and sheen.

D. Colors: As selected by ENGINEER from the Manufacturer's full range.

PART 3 EXECUTION

3.1 PREPARATION

A. Examination:
1. Examine substrates and conditions, with the applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
2. Maximum moisture content of substrates:
a. When measured with an electronic moisture meter as follows:
1) Concrete: 12%.
2) Gypsum board: 12%.
3. Verify suitability of substrates, including surface conditions and compatibility with specified finishes and primers.
4. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

B. Beginning the coating application constitutes the CONTRACTOR's acceptance of substrates and conditions.

C. In accordance with Manufacturer's instructions and recommendations in MPI Architectural Painting Manual applicable to substrates and paint systems indicated.

D. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

E. Protect and cover items indicated not to be painted with suitable material.

F. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

G. Shop Abrasive Blasting:
1. Notify the ENGINEER at least 7 days prior to the start of shop-blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints.
2. Structural steel and similar items, as approved by the ENGINEER, may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop-blast cleaning.

H. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop-blasted or field-blasted and primed or coated.

I. Metal Surface Preparation:
1. Where indicated, meet requirements of the following SSPC Specifications:
a. Solvent cleaning: SP-1.
b. Hand tool cleaning: SP-2.
c. Power tool cleaning: SP-3.
d. Commercial blast cleaning: SP-6.
2. Shop-primed steel substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming in accordance with SSPC-PA 1 for touching up shop-primed surfaces.
3. Brush-off blast cleaning:
a. The equipment, procedure, and degree of cleaning in accordance with SSPC SP 7/NACE No. 4 or SSPC SP 16.
b. Abrasive: Wet or dry blasting sand, grit, or nutshell.
c. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that the surface is cleaned without pitting, chipping, or other damage.
d. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
e. The ENGINEER will approve the trial blast cleaned area and, if acceptable, use the area as a representative sample of surface preparation.
f. Repair or replace surface damaged by blast cleaning.

J. Solvent Cleaning:
1. In accordance with SSPC SP 1.
2. Consists of the removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.

K. Power Tool Cleaning:
   1. In accordance with SSPC SP 11.
   2. The words solvent cleaning, hand tool cleaning, wire brushing, and blast cleaning, or similar words of equal intent in the Contract Documents or in the Paint Manufacturer's Specification, refer to the applicable SSPC Specification.
   3. Where OSHA 29 CFR 1910, OSHA 29 CFR 1926, EPA 40 CFR 261, EPA AP-42, or SSPC PA Guide 10 regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. The Paint Manufacturer's recommendations for wet-blast additives and first coat application shall apply.
   4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
   5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
   6. Welds and adjacent areas:
      a. Prepare such that there is the following:
         1) No undercutting or reverse ridges on weld bead.
         2) No weld spatter on or adjacent to weld or any area to be painted.
         3) No sharp peaks or ridges along weld bead.
      b. Grind embedded pieces of electrode or wire flush with the adjacent surface of weld bead.
   7. Pre-blast cleaning requirements:
      a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
      b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing. Waterjetting in accordance with SSPC SP WJ-1/NACE WJ-1.
      c. Clean small isolated areas as above or solvent clean with suitable solvent and a clean cloth.
   8. Blast cleaning requirements:
      a. Type of equipment and speed of travel: Design to obtain a specified degree of cleanliness; minimum surface preparation is as specified herein and takes precedence over the Paint Manufacturer's recommendations.
      b. Select the type and size of abrasive to produce a surface profile that meets the Paint Manufacturer's recommendations for the particular primer to be used.
      c. Use only dry blast cleaning methods.
      d. Do not reuse abrasive, except for designed recyclable systems.
      e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
   9. Post-blast cleaning and other cleaning requirements:
      a. Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning (no oil or water vapor) or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
      b. Paint surfaces the same day they are blasted. Re-blast surfaces that have begun to rust prior to painting.

L. Concrete Surface Preparation: Prepare concrete surfaces in accordance with SSPC SP 13/NACE No. 6 and ICRI 310.2R. Surface profile shall be in accordance with the Manufacturer's recommendations.

M. Gypsum Board Surface Preparation:
   1. Allow joint treatment to thoroughly dry. Lightly sand joint treatments and topping compounds to produce a uniform, smooth surface. Wipe or brush free of sanding dust.
   2. Fill minor defects with filler compound. Spot prime defects after repair.

N. Acid Etching:
   1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10% solution of HCl.
   2. Application:
      a. Rate: 2 gallons/100 sf.
      b. Work acid solution into the surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
      c. Acid will react vigorously for a few minutes during which time brushing shall be continued.
      d. After bubbling subsides, in approximately 10 minutes, hose down the remaining slurry with high-pressure clean water.
      e. Rinse immediately to avoid the formation of salts on the surface that are difficult to remove.
      f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
   3. Ensure surface is completely dry before the application of paint.
   4. Apply acid etching to obtain a grit sandpaper surface profile. If the surface is not achieved, repeat the treatment.

O. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

P. Upon the Substantial Completion date, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

Q. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave the entire job clean.

3.2 APPLICATION

A. General:
   1. Painting and coating for industrial work as specified in SECTION 09 90 00.
   2. Apply paints in accordance with Manufacturer's instructions and to recommendations in the MPI Architectural Painting Manual.
      a. Use applicators and techniques suited for paint and substrate indicated.
      b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces.

c. Provide prime coats that are compatible with substrate material. Provide finish coats that are compatible with primers used.
d. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
e. The term exposed surfaces includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
f. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
g. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to the Topcoat Manufacturers.

3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
4. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

B. Workmanship:
1. If surfaces are not in proper shape for coating application, repair, rebuild, or refinish before proceeding with the Work. Assume responsibility for inadequate Work caused by improper surface preparation. The application of the first coat does not relieve the responsibility for the base. Do not apply any coats on damp or wet surfaces and in no case until the preceding coat has cured. Avoid contamination or damage to prepared or intercoat surfaces. Clean and re-repair as required.
2. Application: Spread materials evenly without runs or sags and thoroughly brush out. Provide a finish that is free of abrasions, dirt, or other debris and uniform in color and appearance.
a. The number of coats specified is the minimum to be applied. Apply additional coats when undercoats, stains, or other conditions show through the final finish coat until the paint film is of uniform finish, color, and appearance.
3. Roller application: Use a fine nap roller to roll and backroll so a nearly flat or orange peel texture is achieved. Do not use a roller application on metal or wood surfaces. Coating application shall be uniform in color, texture, and shade. Aesthetic defects shall be cause for rejection.
4. Spray application: Apply with airless or air pressure spray equipment as recommended by the Paint Manufacturer for the particular product. Apply each coat in a uniform manner to provide the equivalent thickness of brush coats. Do not double back to build up the film thickness of two coats in one pass.
5. Brush application: Brush paint with equipment and the technique required to achieve a flat and smooth surface without brush marks. Brush out and Work paint onto the surfaces in a uniform, even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, and other surface imperfections are not acceptable.
6. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing only after finishing has completely dried and hardened. Use workmen skilled in the installation of the items removed; install in a manner that does not void warranties.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
1. Prefinished items include the following factory-finished components:
a. Architectural woodwork.
b. Acoustical ceiling panels.
c. Finished mechanical and electrical equipment.
d. Light fixtures.
2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
a. Foundation spaces.
b. Furred areas.
c. Ceiling plenums.
d. Duct shafts.
3. Finished metal surfaces include the following:
a. Anodized aluminum.
b. SST.
c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.
4. Operating parts include moving parts of operating equipment and the following:
a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.
e. Sprinkler heads.

D. Shop-Primed and Factory-Finished Surfaces:
1. Schedule an inspection with the ENGINEER before shop priming or top coating factory-finished items are delivered to the site.
2. Prepare surfaces and spot prime using the specified primer.
3. Apply a mist coat of primer, 1 mil DFT.
4. After welding, prepare and prime holdback areas as required for the paint system. Apply primer in accordance with the Manufacturer's instructions.

E. Film Thickness and Coverage:
   1. Number of coats:
      a. The minimum required without regard to coating thickness.
      b. Additional coats may be required to obtain the minimum required paint thickness depending on method of application, differences in the Manufacturer's products, and atmospheric conditions.
   2. Application thickness:
      a. Do not exceed the Manufacturer's recommendations.
      b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
   3. Visually inspect concrete, masonry, non-ferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
   4. Give particular attention to edges, angles, flanges, and other similar areas where insufficient film thicknesses are likely to be present and ensure proper DFT in these areas.
   5. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

F. Factory-Applied Priming:
   1. Priming or priming and finishing of certain surfaces may be specified to be factory-applied or shop-applied by fabricators.
   2. Carefully examine the Contract Documents for priming or finishing Work installed by other trades to avoid duplications or omissions.

3.3 PROTECTION

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
C. Protect Work of other trades against damage from paint application. Correct damage to Work of other trades by cleaning, repairing, replacing, and refinishing, as approved by ENGINEER, and leave in an undamaged condition.
D. Mask openings in motors to prevent paint and other materials from entering.
E. Protect surfaces from overspray that are adjacent to or downwind of the Work area.
F. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
G. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.4 QUALITY CONTROL

A. DFT Testing: The OWNER will engage the services of a qualified testing and inspecting agency to inspect and test paint for DFT.
   1. The CONTRACTOR shall touch up and restore painted surfaces damaged by testing.
   2. If test results show the DFT of applied paint does not in accordance with the Paint Manufacturer's recommendations, the CONTRACTOR shall pay for testing and apply additional coats as needed to provide DFT that complies with the Paint Manufacturer's recommendations.

B. Inspection: Leave staging and lighting in place until the ENGINEER has inspected the surface or coating. Replace staging removed prior to approval by the ENGINEER. Provide additional staging and lighting as requested by the ENGINEER.
C. Unsatisfactory Application:
   1. If an item has an improper finish color or insufficient film thickness, clean the surface and topcoat with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the Paint Manufacturer.
   2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
   3. Repair defects in accordance with the Paint Manufacturer's recommendations.

D. Damaged Coatings, Pinholes, and Holidays:
   1. Feather edges and repair in accordance with the Paint Manufacturer's recommendations.
   2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on the extent of repair and appearance, a finish sanding and topcoat may be required.
   3. Apply finish coats, including touch up and damage-repair coats, in a manner that will present a uniform texture and color-matched appearance.

E. Manufacturer's Services:
   1. The Paint Manufacturer's Representative shall be present at the site:
      a. On the first day of the application of any coating system.
      b. A minimum of two additional site inspection visits, to provide the Manufacturer's certificate of proper installation.
      c. As required to resolve field problems attributable to or associated with the Manufacturer's product.
      d. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.5 ARCHITECTURAL PAINTING AND COATING SCHEDULE

A. Paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the ENGINEER before starting the Work.

B. System No. 101, Exterior Metal Surfaces, including Hollow Metal Doors and Frames, Rolling Door Angle Jambs, Miscellaneous Steel Lintels, Ferrous Steel Beams and Columns:

Surface Preparation	Water-Based Light Industrial Coating System MPI EXT 5.1C	
SSPC SP 6/NACE No. 3	Prime Coat:	Primer, rust-inhibitive, alkyd MPI #79.
	Intermediate Coat:	Light industrial coating, exterior, water based, matching topcoat.
	Topcoat:	Light industrial coating, exterior, water based, acrylic semi-gloss (MPI Gloss Level 5), MPI #163.

C. System No. 102, Interior Metal Surfaces, including Hollow Metal Doors and Frames, Rolling Door Angle Jambs, Steel Columns, Miscellaneous Steel Lintels:

Surface Preparation	Water-Based Light Industrial Coating System MPI INT 5.1B	
SSPC SP 6/NACE No. 3	Prime Coat:	Primer, rust-inhibitive, water based MPI #107.
	Intermediate Coat:	Light industrial coating, interior, water based, matching topcoat.
	Topcoat:	Light industrial coating, interior, water based, acrylic semi-gloss (MPI Gloss Level 5), MPI #153.

D. System No. 103, Interior Metal Surfaces, including Steel Roof Decking, Structural Steel Roof Joists and Framing:

Surface Preparation	Epoxy System over Epoxy Primer System MPI INT 5.1L	
SSPC SP 6/NACE No. 3 or SSPC SP 8	Prime Coat:	Primer, epoxy, anti-corrosive MPI #101.
	Intermediate Coat:	Epoxy coating, interior, solvent based, matching topcoat.
	Topcoat:	Epoxy coating, interior, solvent based, semi-gloss (MPI Gloss Level 5), MPI #177.

E. System No. 104, Interior Concrete Floors:

Surface Preparation	Epoxy System with SRA MPI INT 3.2L	
In accordance with Concrete Surface Preparation	First Coat:	Epoxy High Build MPI #108.
	Intermediate Coat:	Epoxy High Build matching topcoat.
	Topcoat:	Epoxy coating, interior, solvent based, semi-gloss (MPI Gloss Level 5), MPI #108.

F. System No. 105, Interior Concrete Walls and Ceilings:

Surface Preparation	Water-Based Light Industrial Coating System MPI INT 3.1L	
In accordance with Concrete Surface Preparation	Prime Coat:	Alkali Resistant Primer water based, interior, MPI #3.
	Intermediate Coat:	Light industrial coating, interior, water based, matching topcoat.
	Topcoat:	Light industrial coating, interior, water based, acrylic semi-gloss (MPI Gloss Level 5), MPI #153.

G. System No. 106, Interior Wood to receive paint:

Surface Preparation	Latex System over Alkyd Primer MPI INT 6.2A	
In accordance with Wood Surface Preparation	Prime Coat:	Alkyd Primer Sealer, interior, MPI #45.
	Intermediate Coat:	Latex coating, interior, matching topcoat.
	Topcoat:	Latex coating, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

H. System No. 107, Interior Galvanized Metal, Copper and Non-Ferrous Metal Alloy:

Surface Preparation	High Performance Architectural Latex System over Galvanized Primer MPI INT 5.3M	
In accordance with Wood Surface Preparation	Prime Coat:	Waterborne Galvanized Primer, interior, MPI #134.
	Intermediate Coat:	High Performance Architectural Latex coating matching topcoat.
	Topcoat:	High Performance Architectural Latex coating, interior, (MPI Gloss Level 5), MPI #141.

I. System No. 108, Interior Standing Wood Trim:

Surface Preparation	Polyurethane Varnish over Waterborne Stain MPI INT 6.3EE	
In accordance with Wood Surface Preparation	Prime Coat:	Waterborne Stain, MPI #186.
	First Intermediate Coat:	Polyurethane Varnish matching topcoat.
	Second Intermediate Coat:	Polyurethane Varnish matching topcoat.
	Topcoat:	Polyurethane Varnish, (MPI Gloss Level 4), MPI #57.

J. System No. 109, Interior Concrete Masonry Units:

Surface Preparation	High Performance Architectural Latex System over Latex Block Filler MPI INT 4.2D	
In accordance with Wood Surface Preparation	Prime Coat:	Latex Block Filler, interior/Exterior, MPI #4.
	Intermediate Coat:	High Performance Architectural Latex coating matching topcoat.
	Topcoat:	High Performance Architectural Latex coating, interior, (MPI Gloss Level 5), MPI #141.

K. System No. 109, Interior Concrete Masonry Units:

Surface Preparation	High Performance Architectural Latex System over Latex Block Filler MPI INT 4.2D	
In accordance with Wood Surface Preparation	Prime Coat:	Latex Block Filler, interior/Exterior, MPI #4.
	Intermediate Coat:	High Performance Architectural Latex coating matching topcoat.
	Topcoat:	High Performance Architectural Latex coating, interior, (MPI Gloss Level 5), MPI #141.

L. System No. 110, Interior Concrete Masonry Units:

Surface Preparation	Epoxy System over Epoxy Primer System MPI INT 4.2G	
In accordance with Wood Surface Preparation	Prime Coat:	Epoxy Block Filler, MPI #116.
	Intermediate Coat:	Epoxy coating, interior, solvent based, matching topcoat.
	Topcoat:	Epoxy coating, interior, solvent based, semi-gloss (MPI Gloss Level 5), MPI #177.

M. System No. 104, Interior Gypsum Board and Plaster (Eggshell):

Surface Preparation	Latex over Latex Sealer System MPI INT 9.2A (Eggshell):	
In accordance with Gypsum Board or Plaster Surface Preparation	Prime Coat:	Primer sealer, latex, interior, MPI #50.
	Intermediate Coat:	Latex, interior, matching topcoat.
	Topcoat:	Latex, interior (MPI Gloss Level 3), MPI #52.

N. System No. 105, Interior Gypsum Board and Plaster (Semi-Gloss):

Surface Preparation	Latex over Latex Sealer System MPI INT 9.2A (Eggshell):	
In accordance with Gypsum Board or Plaster Surface Preparation	Prime Coat:	Primer sealer, latex, interior, MPI #50.
	Intermediate Coat:	Latex, interior, matching topcoat.
	Topcoat:	Latex, interior (MPI Gloss Level 4), MPI #43.

END OF SECTION

SECTION 09 97 00
CHEMICAL CONTAINMENT COATING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for chemical containment coating systems.

B. Related Sections:

1. SECTION 09 67 16 – RESINOUS FLOORING.
2. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. ASTM International (ASTM):

1. D 6386 – Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware – Surfaces for Painting

B. Environmental Protection Agency (EPA):

1. 40 CFR 261 – Identification and Listing of Hazardous Waste
2. AP-42 – Compilation of Air Pollutant Emission Factors – Volume I: Stationary Point and Area Sources, Chapter 13.2.6 – Abrasive Blasting

C. International Concrete Repair Institute (ICRI):

1. 310.2R – Selecting and Specifying Concrete Surface Preparation

D. NACE International (NACE):

1. SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
2. SP0287 – Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

E. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910 – Occupational Safety and Health Standards
2. 29 CFR 1926 – Safety and Health Regulations for Construction

F. The Society for Protective Coatings (SSPC):

1. PA 2 – Determining Compliance to Required DFT
2. PA Guide 10 – Contractor ESH Requirements
3. SP 16 – Brush-Off Blast Cleaning and Non-Ferrous Metals

G. The Society for Protective Coatings/NACE International (SSPC/NACE):

1. SSPC SP 10/NACE No. 2 – Near-White Blast Cleaning
2. SSPC SP 7/NACE No. 4 – Brush-Off Blast Cleaning
3. SSPC SP 13/NACE No. 6 – Surface Preparation of Concrete
4. SSPC SP WJ-1/NACE WJ-1 – Waterjetting to Bare Substrate

1.3 DEFINITIONS

A. Coverage: Total minimum DFT in mils or sfpg.

B. Paint: The term paint, as used herein, means coating systems materials including primers, sealers, fillers, emulsions, enamels, epoxy, stains, lacquers, varnishes, and other applied materials, whether used in prime coats, intermediate coats, or finish coats.

1.4 SEQUENCING AND SCHEDULING

A. Work Not Included:

1. Nonmetallic materials such as FRP, glass, and porcelain.
2. Plastic surfaces of PVC, PP, or PE.
3. Surfaces of anodized or prefinished aluminum, SST, bronze, brass, and chromium plate.
4. Moving parts of operating equipment, mechanical or electrical moving parts, linkages, sensing devices, and motor shafts.
5. Buried concrete surfaces in contact with soil.
6. Prefinished electrical items such as motors, motor control centers, switchboards, switchgear, panelboards, transformers, and disconnect switches.
7. Prefinished architectural items such as acoustical tile, cabinets, building louvers, overhead coiling doors, sectional doors, and wall panels.

1.5 SUBMITTALS

A. Product Data:

1. Product and safety data and other information for proposed products.
2. A copy of the Manufacturer's coating application quality assurance manual.

B. Provide a paint schedule that lists surface preparation, coating product, location, DFT, number of coats, and cure time.

C. Submit the product application procedure, current paint data sheet, safety data sheet, and a copy of the QA/QC report for surface preparation and coating application. Include complete surface preparation and cleaning procedures, as well as application equipment. Include anchor profiles, WFT, adhesion tests, temperature, humidity, holiday tests, and any other measurements taken for QA and QC during surface preparation and application.

D. Field-Applied Coatings Subject to Immersion Service:

1. Provide complete environmental condition information taken before abrasive blasting or coating. Provide environmental data at 2-hour increments if the prepared surface is not coated within 12 hours. Information provided shall include temperature, relative humidity, location description, time, date, technician name, and company.
2. Submit photos for the field application of coatings. Submit one photo of the field-blasted surface prior to the coating application for each area that is measured for anchor profile. Submit photos of each field-applied coat prior to the application of subsequent coats for each DFT measurement taken in accordance with SSPC PA 2.

E. Submit the final field testing report to the ENGINEER within 2 weeks of the Substantial Completion date.
F. Samples:
1. Initial selection: Complete color card or actual color chips illustrating the range of color availability.
2. Two samples, 12 inch by 12 inch, illustrating the thickness and textures for each surface finishing product scheduled.
G. Provide the ENGINEER with a schedule of systems by location.
H. Warranty Documentation:
1. Sample warranty.
2. Warranty.
I. Supplements listed in this Section.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: A minimum of 5 years of documented experience in the Work of this Section.
B. Installer Qualifications:
1. A minimum of 5 years of documented experience in the Work of this Section.
2. Approved by the Manufacturer.
C. Provide finish coats compatible with substrate materials or with prime coats.
D. First quality preparation, painting, and finishing is required. Dirt, grit, or dust in the paint or finish; runs, sags, or drips of paint or finish; or irregularity of finish is cause for rejection. Remove rejected finishes; repair, reprime, and refinish as required to achieve a first quality finish.
E. Regulatory Requirements:
1. Meet federal, state, and local requirements limiting the emission of VOCs.
2. Perform surface preparation and painting in accordance with the following:
a. SSPC SP 10/NACE No. 2.
b. SSPC SP 7/NACE No. 4.
c. SSPC SP 13/NACE No. 6.
d. ICRI 310.2R.
e. Federal, state, and local agencies having jurisdiction.
F. Mockup:
1. Size: As required by the ENGINEER.
2. Before proceeding with Work under this Section, finish one complete space or item of each containment system and color required to show the quality of workmanship, materials, finish, texture, colors, and special details in compliance with the requirements of this Section. Provide one mockup for finishing process related spaces and items and one mockup for finishing architectural finished spaces and items.
3. After it is approved, sample spaces and items shall serve as a standard for similar Work throughout the site.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Container label: Include the Manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
B. Paint materials: Store at an ambient temperature from 45°F to 90°F in a ventilated area or in accordance with the Manufacturer's instructions.

1.8 SITE CONDITIONS
A. Do not apply paint in temperatures or moisture conditions outside of the Manufacturer’s recommended maximum or minimum allowable.
B. Work and storage areas shall be free of dust during the application of the layers of the coating system. Do not apply finishes in spaces with accumulated rubbish, dust, or dirt or where construction activity is present.
C. Do not perform final abrasive blast cleaning whenever the relative humidity exceeds 85%, or whenever the surface temperature is less than 5°F above the dew point of ambient air.
D. The chemical resistive barrier surface shall be top coated within 2 months or as required by the Paint Manufacturer.
E. Provide a lighting level of 80 foot-candles measured mid-height at the substrate surface.

1.9 WARRANTY
A. Warranty for 2 years from the Substantial Completion date for the satisfactory performance and installation of the painting and coating system and associated appurtenances, including correction, or at the option of the OWNER, removal and replacement of Work found to be defective. The OWNER shall be named as the beneficiary.
B. The CONTRACTOR and the Paint Manufacturer shall jointly furnish the warranty.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Chemical Containment System:
1. Dudick, Inc.
2. Sherwin Williams
3. Tnemec Coatings
4. Stonhard
B. Testing Equipment:
1. Magnetic type DFT gauge:
a. ElektroPhysic, MikroTest
2. Low-voltage wet sponge electrical holiday detector:
a. Tinker and Rasor

2.2 MATERIALS

A. General:

1. Containment system: Multi-layer containment system, furnished through one Manufacturer, field-applied primers or intermediate layers produced by the same Manufacturer as the finish coat(s).
2. Thinners, cleaners, driers, and other additives: As recommended by the Coating Manufacturer.
3. Application equipment: Equipment as recommended by the Coating System Manufacturer.

B. Products:

Product	Definition
Epoxy, Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, non-shrinking, suitable for application to concrete.
Epoxy, Primer	Epoxy primer, high-build, as recommended by the Paint Manufacturer for the concrete surface to be coated.
Epoxy, Mortar Basecoat	Modified flexible polyamine epoxy, 100% volume solids, suitable for bridging small substrate cracks in concrete containment structures.
Epoxy, Base / Saturant Coat	Modified polyamine novolac epoxy, 100% volume solids, suitable for combination with a fiberglass reinforcement mat for secondary containment systems.
Epoxy, Top Coat	Polyamine novolac epoxy, 100% solids, suitable for chemical exposure service coating for walls, floors and other surfaces as part of secondary containment systems.

C. Colors: As selected by the ENGINEER from the Manufacturer's full color range as specified in SECTION 09 90 00.

2.3 FINISHES

A. Provide surface traction where shown on the Drawings and where recommended by the Manufacturer.

2.4 MIXES

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by the Coating System Manufacturer.
2. No partial batches are permitted.
3. Do not use multiple-component coatings mixed beyond their pot life.
4. Furnish small quantity kits for surface repair.
5. Mix only components specified and furnished by the Paint Manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead and lead compounds.

PART 3 EXECUTION

3.1 PREPARATION

A. General: Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the most stringent recommendations of the Paint Manufacturer whose product is to be applied. The more stringent requirements shall apply. If any surface is found to be unsuitable to produce a proper finish, do not apply material until the surfaces are made satisfactory. Application of paint to any surface shall be deemed to be acceptance of that surface and full responsibility shall be borne by the CONTRACTOR.

B. Field Abrasive Blasting: Perform blasting where specified and as required to restore damaged surfaces previously field-blasted and primed or coated.

C. Metal Surface Preparation:

1. Where shown on the Drawings, in accordance with the Manufacturer's direction as to the SSPC specification. Metal surfaces shall be minimized within the containment area.
2. The words solvent cleaning, hand tool cleaning, wire brushing, and blast cleaning, or similar words of equal intent in the Contract Documents or in the Coating System Manufacturer's specification, refer to the applicable SSPC specification.
3. Where OSHA 29 CFR 1910, OSHA 29 CFR 1926, EPA 40 CFR 261, EPA AP-42, or SSPC PA Guide 10 regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Consult with the Coating System Manufacturer's for recommendations for use of wet-blast, appropriate additives, and first coat application requirements.
4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Welds and adjacent areas:
   a. Prepare such that there is the following:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with the adjacent surface of weld bead.
7. Pre-blast cleaning requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing. Waterjetting in accordance with SSPC SP WJ-1/NACE WJ-1.

c. Clean small isolated areas as stated or solvent clean with suitable solvent and a clean cloth.

8. Blast cleaning requirements:
   a. Type of equipment and speed of travel: Design to obtain a specified degree of cleanliness; minimum surface preparation is as specified herein and takes precedence over the Coating System Manufacturer's recommendations.
   b. Select the type and size of abrasive to produce a surface profile in accordance with the Coating Systems Manufacturer's recommendations for the particular primer to be used.
   c. Use only dry blast cleaning methods.
   d. Do not reuse abrasive, except for designed recyclable systems.
   e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
9. Post-blast cleaning and other cleaning requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry air blast cleaning (no oil or water vapor) or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Re-blast any surfaces that have begun to rust prior to painting.

D. Concrete Surface Preparation:
1. Do not begin until 30 days after concrete has been placed.
2. In accordance with ICRI 310.2R, CSP 4-6, Form G-1.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Verify the required acid-alkali balance has been achieved.
5. Brush-off blast the concrete surface to remove loose concrete and laitance and provide a tooth for binding. Upon approval by the ENGINEER, the surface may be cleaned by the acid etching method. Approval is subject to producing a desired profile. Acid etching of vertical or overhead surfaces shall not be allowed.
6. Secure the Coating System Manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
7. Concrete wall surface preparation:
   a. Patch tie holes in accordance with installation guidance by the Coating System Manufacturer.
   b. Fill voids with a product as directed by the Coating System Manufacturer.
8. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

E. Plastic Surface Preparation: FRP equipment with an integral colored gel coat does not require painting, provided the color is as selected.

F. Masonry Surface Preparation:
1. Complete and cure masonry construction for 14 days or more before starting surface preparation Work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and dry prior to painting, unless otherwise required for proper adhesion.
6. Masonry surfaces to be painted: Uniform texture and free of surface imperfections that would impair the intended finished appearance.

G. Wood Surface Preparation: Wood surfaces shall not be used in conjunction with the containment system.

H. Gypsum Board Surface Preparation: Gypsum surfaces shall not be used in conjunction with the containment system.

I. Plaster Surface Preparation: Plaster surfaces shall not be used in conjunction with the containment system.

J. Non-Ferrous Metal Preparation for Coating: The non-ferrous surface shall be coated within 2 days if it is stored in an environmentally controlled space to avoid coating over the zinc oxide and zinc hydroxide layer that forms. After 2 days, the surface shall be sweep blasted and the coating applied within 1 hour of the blasting. The blasting shall be performed in accordance with ASTM D 6386 and SSPC SP 16, including:
1. Reduced blast pressure, 40 psi or less.
2. Reduced blasting dwell time.
3. Increased distance of blast nozzle from the surface, 18 inches to 24 inches.
4. Reduced blast angle, 30 degrees to 60 degrees rather than 90 degrees.
5. A softer blast media: Aluminum/magnesium silicate, corncobs, walnut shells, corundum, limestone, or mineral sands with a Mohr's hardness level 5 or less.
6. No resurfacing with sanders or grinders.
7. If the item is stored outside after galvanizing, the surface preparation shall be performed as weathering has begun.
8. A minimum surface profile of 0.75 mil on the bare metal surface is required.
9. Intact coatings are required to be roughened to the degree specified for the coating to be used.

K. Provide the ENGINEER a minimum of 7 days advance notice to the start of field surface preparation Work and coating application Work.

L. Schedule an inspection of cleaned surfaces and all coats prior to successive coat in advance with the ENGINEER.

M. Measure the moisture content of surfaces using an electronic moisture meter. Do not apply coating system components unless the moisture content is below the limits as defined by the Coating System Manufacturer.

3.2 APPLICATION

A. General:
1. Paint surfaces within the containment zone of each bulk chemical storage area up to a level that is 12 inches above the peak holding capacity. Surfaces include new masonry, concrete, and metal surfaces, except as specified otherwise.
2. When a chemical containment system is part of a complete resinous flooring system, include chemical resistant topcoat with the flooring system and apply as specified in SECTION 09 67 16.
3. Apply the coating system in accordance with the Contract Documents and the Coating System Manufacturer's recommendations. The more stringent requirements shall apply. Allow sufficient time between coats to ensure thorough drying or curing of previously applied paint.
4. Thoroughly clean surfaces prior to coating to remove free or loose particles.
5. On pipelines or conduits, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
6. Follow the Manufacturer's recommended storage procedures. Do not store coatings in direct sunlight.

B. Workmanship:
1. If surfaces are not in proper shape for coating application, repair, rebuild, or refinish before proceeding with the Work. Assume responsibility for inadequate Work caused by improper surface preparation. The application of the first layer does not relieve the responsibility for the adequate preparation of the base. Do not apply any coats on damp or wet surfaces and in no case until the preceding coat has cured. Avoid contamination or damage to prepared or intercoat surfaces. Clean and re-repair as required.
2. Application: Spread materials evenly without runs or sags and thoroughly even out layers following the Manufacturer's guidance. Provide a finished surface for each layer that is free of abrasions, dirt, or other debris and uniform in color and appearance.
    a. The number of layers specified is the minimum to be applied. Apply additional top coats if undercoats, stains, or other conditions show through the final finish coat until the containment system surface is of uniform finish, color, and appearance.
3. Roller application: When allowed by the Manufacturer, use a nap roller in accordance with the Manufacturer's instructions to roll and backroll to achieve the required texture. Do not use a roller application on metal or wood surfaces. The coating application shall be uniform in color, texture, and shade. Aesthetic defects shall be cause for rejection.
4. Spray application: When allowed by the Manufacturer, apply with airless or air pressure spray equipment as recommended by the Coating System Manufacturer for the particular product. Apply each coat in a uniform manner to provide the equivalent wet film thickness of brush coats. Do not double back to build up the film thickness of two coats in one pass.
5. Trowel application: Smooth coating material with equipment and the technique required to achieve the required surface texture. Work coating onto the surfaces in a uniform, even film. Holidays, voids, air pockets, and other surface imperfections are not acceptable.
6. Brush application: Brush paint with equipment and the technique required to achieve the required surface texture without brush marks. Brush out and work paint onto the surfaces in a uniform, even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, and other surface imperfections are not acceptable.
7. Replace plates, hardware, and fittings removed prior to finishing only after finishing has completely dried and hardened. Use workmen skilled in the installation of the items removed; install in a manner that does not void warranties.

C. Porous Surfaces, such as Concrete and Masonry:
1. Filler/surfacer: Use the Coating System Manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime coat: Consult with the Coating System Manufacturer to determine if thinning is required to provide maximum penetration and adhesion.
    a. Type and amount of thinning: Determined by the Coating System Manufacturer and dependent on surface density and type of coating.

D. Film Thickness and Coverage:
1. Number of coats:
    a. Provide the minimum required as defined by the Manufacturer without regard to coating thickness.
    b. Additional coats may be required to obtain the minimum required paint thickness depending on method of application, differences in the Manufacturer's products, and atmospheric conditions.
2. Application thickness:
    a. Do not exceed the Manufacturer's recommendations.
    b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Visually inspect concrete, masonry, metal, and plastic surfaces to ensure proper and complete coverage has been attained.
4. Give particular attention to edges, angles, flanges, and other similar areas where insufficient film thicknesses are likely to be present and ensure proper DFT in these areas.
5. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.3 PROTECTION

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and the painting process.
D. Mask openings in motors to prevent paint and other materials from entering.
E. Protect surfaces from overspray that are adjacent to or downwind of the Work area.

3.4 QUALITY CONTROL

A. Testing:
   1. Surface preparation testing:
      a. Measure the prepared surface profile using magnetic type gauge or replica tape in accordance with NACE SP0287.
      b. Verify the surface is free of debris and particulate prior to the coating application using clear tape.
   2. Thickness testing:
      a. Measure the coating thickness specified in mils with a suitable DFT gauge in accordance with the Coating System Manufacturer's installation instructions.
      b. Check each coat for the correct DFT.
      c. Wait the minimum time after the application of coating as defined by the Coating System Manufacturer before testing.
   3. Continuity testing:
      a. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with a low-voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
      b. After repaired and recoated areas have dried sufficiently, retest each repaired area.
      c. Final tests may also be conducted by the ENGINEER.
B. Inspection: Leave staging and lighting in place until the ENGINEER has inspected the surface or coating. Replace staging removed prior to approval by the ENGINEER. Provide additional staging and lighting as requested by the ENGINEER.
C. Unsatisfactory Application:
   1. If an item has an improper finish color or insufficient film thickness, clean the surface and recoat with specified material to obtain the specified coverage. Obtain specific surface preparation information from the Coating System Manufacturer.
   2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
   3. Repair defects in accordance with the written recommendations of the Coating System Manufacturer.
D. Damaged Coatings, Pinholes, and Holidays: Repair in accordance with the recommendations of the Coating System Manufacturer.
E. Manufacturer's Services:
   1. The Coating System Manufacturer's Representative shall be present at the site:
      a. On the first day of the application of any coating system.
      b. A minimum of two additional site inspection visits, to provide the Manufacturer's certificate of proper installation.
      c. As required to resolve field problems attributable to or associated with the Manufacturer's product.
      d. To verify full cure of coating prior to coated surfaces being placed into service as a containment system.

3.5 CLEANING

A. Clean and prepare each layer surface in accordance with the Coating System Manufacturer's installation instructions.
B. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.
C. Upon the substantial completion date, remove staging, scaffolding, and containers from the site or destroy in a legal manner.
D. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave the entire job clean.

3.6 CHEMICAL CONTAINMENT COATING SYSTEM SCHEDULE

A. Coat surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the ENGINEER before starting the Work.
B. System No. 1, Containment Systems for Corrosive Chemicals: Structures including, but not limited to, containment areas that have the potential be immersed directly in the chemical when functioning as a secondary containment, including containment area, pull boxes within the chemical building, and truck unloading stations.

Surface Preparation	**Paint Material**	**Minimum Coats, Cover**
Concrete: SSPC SP 13/NACE No. 6 ICRI 310.2R, CSP 4-6 Steel: SSPC SP 10/NACE No. 2	Epoxy, Filler/Surfacer	1 coat, 1/16 inch to 1/4 inch per coat, maximum 1/2 inch total thickness
	Epoxy, Primer	1 coat, 6 mils to 8 mils DFT
	Epoxy, Mortar Basecoat	60 mils to 80 mils, 1/16 inch to 1/4 inch per lift; maximum 1/2 inch thickness
	Epoxy, Base/ Saturant Coat	2 coats, 65 mils with saturated fiberglass mat
	Epoxy, Top Coat	1 coat, 6 mils to 8 mils DFT

C. System No. 2, Containment Systems for Non-Corrosive Chemicals: Structures including, but not limited to, containment areas that have the potential be immersed directly in the chemical when functioning as a secondary containment, including containment area within the chemical building.

Surface Preparation	Paint Material	Minimum Coats, Cover
Concrete: SSPC SP 13/NACE No. 6 ICRI 310.2R, CSP 4-6 Steel: SSPC SP 10/NACE No. 2	Epoxy, Primer – Ferrous Metal	1 coat, 2.5 mils DFT
	Polyurethane, Enamel	2 coats, 3 mils DFT

3.7 SUPPLEMENTS

A. SUPPLEMENT A – Paint System Data Sheet (PSDS)

B. SUPPLEMENT B – Paint Product Data Sheet (PPDS)

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A – PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system. Include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Minimum Coats, Coverage

INTENTIONALLY BLANK

SUPPLEMENT B – PAINT PRODUCT DATA SHEET

Complete and attach the Manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide the Manufacturer's recommendations for the following parameters at temperature (°F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Minimum Recoat Time			
Maximum Recoat Time			

Provide the Manufacturer's recommendations for the following:
Mixing Ratio: _____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: minimum: _____ maximum: _____

Surface Temperature Limitations: minimum: _____ maximum: _____

Surface Profile Requirements: minimum: _____ maximum: _____

INTENTIONALLY BLANK

SECTION 09 97 13.01
POLYURETHANE COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for polyurethane coatings.

B. Related Sections:

1. SECTION 09 90 00 – PAINTING AND COATING
2. SECTION 09 97 13.02 – LIQUID-EPOXY LININGS AND COATINGS
3. SECTION 09 97 13.05 – HEAT SHRINK COATINGS

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. C222 – Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings

B. ASTM International (ASTM):

1. D 16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications
2. D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

C. International Organization for Standardization (ISO):

1. 8502-3 – Preparation of Steel Substrates Before Application of Paints and Related Products – Tests for the Assessment of Surface Cleanliness – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)

D. NACE International (NACE):

1. SP0274 – High Voltage Electrical Inspection of Pipeline Coatings
2. SP0287 –Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

E. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

F. The Society for Protective Coatings (SSPC):

1. PA 2 – Determining Compliance to Required DFT
2. QP 1 – Field Industrial Contractor Qualification
3. SP 1 – Solvent Cleaning
4. SP 2 – Hand Tool Cleaning
5. SP 3 – Power Tool Cleaning
6. VIS 1 – Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast-Cleaning

G. The Society for Protective Coatings/NACE International (SSPC/NACE):

1. SSPC SP 10/NACE No. 2 – Near White Blast Cleaning

1.3 COORDINATION

A. Observation of Work:

1. Notify the ENGINEER in writing 14 days in advance of coating Work to allow for scheduling for shop or field observation. Notify the ENGINEER in writing a minimum of 3 days prior to actual surface preparation Work.
2. Allow the ENGINEER full access to the facilities and to appropriate documentation regarding the coating application.

1.4 SUBMITTALS

A. Product Data:

1. Catalog data and other information for proposed products; provide product data for holdback and repair materials.
2. A copy of the Manufacturer's coating application QA manual.
3. NACE CIP Level 3 qualifications and written approval of coating application procedures and workmanship.

B. Submit the product application procedure, current PDS, SDS, and a copy of the QA/QC report for surface preparation and coating application. Include complete surface preparation and cleaning procedures, as well as application equipment. Include anchor profiles, DFT, adhesion tests, temperature, humidity, holiday tests, and any other measurements taken for QA and QC during surface preparation and application.

1. Submit QC data verifying the coating has been inspected and is free of defects prior to the transportation of coated pipe and appurtenances from the coating facility to the Work location.
2. Provide documentation that coating system DFT is in conformance with NSF/ANSI 61.

C. Provide a paint schedule that lists surface preparation, coating product, location, DFT, number of coats, and cure time.

D. Provide the ENGINEER with a copy of the coating application QA manual. Strict conformance to the manual requirements is required. Coating applied deviating from the requirements will be rejected. Rejected coating shall be removed and reapplied.

E. Field-Applied Coatings: Provide complete environmental condition information taken before abrasive blasting or coating. Provide environmental data at 2-hour increments if prepared surface is not coated within 1 day. Information provided shall include temperature, relative humidity, location description, time, date, technician name, and company.

1. Submit photos for field application of coatings. Submit one photo of field-blasted surface prior to coating application for each area that is measured for anchor profile. Submit photos of each field-applied coat prior to application of subsequent coats for each DFT measurement taken based on SSPC PA 2. Photos are not required for shop-applied coating application unless otherwise noted by the ENGINEER.

F. Submit the final field testing report to the ENGINEER within 2 weeks of the Substantial Completion date.

G. QC Testing Equipment:

1. Provide product data sheets for testing equipment for measuring DFT, holiday detection, and adhesion testing. Include information for any sensors, wands, springs, or other attachments used to provide QC testing.
2. Provide current calibration certificates for testing equipment updated within 6 months of the date of testing. Provide equipment settings required for testing based on the planned DFT of coating material.

1.5 QUALITY ASSURANCE

A. Provide certification by the Coating Manufacturer as an approved Applicator.

B. Coating Applicator:

1. A minimum of 5 years of documented experience in the Work of this Section and certification of attendance at the Coating Manufacturer's training class.
2. Provide monitoring systems approved by the Manufacturer that records pipe, fitting, and coating conditions during the coating application. Recorded monitoring parameters include, but are not limited to, air temperature and humidity, pipe and fitting temperature, surface preparation, coating thickness, and holiday testing.
3. SSPC QP 1 certification is required for field coating applications.

C. Coating Manufacturer: Provide a representative trained and knowledgeable in technical aspects of the Manufacturer's products and systems available for technical support.

D. Coating Application:

1. Surface preparation, application, and testing under the supervision of and approved by NACE CIP Level 3.
2. Prepare surface and apply coating following the most stringent recommendations as specified in the Manufacturer's PDS.

E. NACE CIP Level 3:

1. Provide name and contact information.
2. Currently certified by NACE.
3. Attend progress meetings as required.
4. Oversee surface preparation and coating application.

F. Polyurethane Color:

1. Recycled water piping coating: Pantone 2577U or ENGINEER-approved color.
2. Potable water coating: Blue.
3. Raw water: John Deere green.

G. Provide contrasting colors for primer, intermediate, and top coats.

1. Provide finish colors as specified in SECTION 09 90 00.

H. Field Hold Points:

1. For coatings subject to buried or submerged service, ENGINEER approval is required to continue Work following finished surface preparation. Provide time for ENGINEER inspection of prepared surface and coating in accordance with SSPC PA 2.
2. For coatings subject to buried or submerged service, ENGINEER approval is required after application of each coat and prior to application of the subsequent coat.

I. QC: Testing shall be performed by the coating applicator, third-party inspector, or as approved by the ENGINEER.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle finished coated steel pipe in a manner that protects the pipe and the coating from damage.

B. Coated pipe shall not be dragged, pushed, dropped, or rolled on the ground. During handling and storage, ensure metal tools, tongs, chain slings, and equipment do not directly contact the coated pipe.

C. Store coated pipe in a manner that prevents damage to the pipe and coating in accordance with the Coating Manufacturer's recommendations.

D. Transportation: Repair any damage to polyurethane coatings caused during transportation and installation.

E. Packaging:

1. Provide coating materials in the Manufacturer's original, unopened containers.
2. Containers shall be plainly marked with the name and address of the Manufacturer, type of material, batch or lot number, date of manufacture, storage conditions, and information required by federal, state, and local regulations.

F. Storage:

1. Store and protect materials from the elements; store in accordance with the Manufacturer's PDS.
2. Maintain temperature ranges in the storage areas within the Manufacturer's recommended limits.
3. If coated materials are stored in direct sunlight and show signs of chalking or other degradation, DFT measurements and adhesion tests shall be performed to ensure adequate coating thickness is achieved prior to installation. Do not store coated pipe in direct sunlight for a period greater than 2 years.

G. Do not use material that has exceeded the Manufacturer's storage stability period as specified in the PDS.

1.7 SITE CONDITIONS

A. General:

1. Products shall comply with federal, state, and local requirements limiting the emission of VOCs and worker exposure to such compounds.
2. Products shall comply with federal, state, and local air pollution requirements for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
3. Abrasive blast cleaning or coating shall not be done when:
   a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the Coating Manufacturer.
   b. There is a dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather conditions, or under conditions that could cause icing on metal surfaces.
   c. Relative humidity in work area exceeds 85% or it is expected that surface temperatures will drop below 5°F above the dew point at any time during surface preparation or application.

B. Temperature Control: In cold weather, prior to the coating application, if moisture collects on the pipe and the fitting surface, or if the temperature of the pipe and the fitting is less than 45°F, preheat pipe/fitting to a temperature of 50°F or 5°F above the dew point, whichever is greater.

C. Dehumidification and Heating:
1. Provide dehumidification and heating equipment when necessary for shop or field environmental control during surface preparation and coating application. Properly size equipment to maintain a dew point temperature at least 5ºF below the surface temperature of metal surfaces to be cleaned and coated.
2. Prevent cleaned metal surfaces from flash rusting and condensation or icing on the prepared surface throughout surface preparation and the coating application.
3. Provide properly trained personnel in the O&M of dehumidification equipment.
4. Reblast flash rusted metal surfaces and remove damaged coatings due to equipment malfunction, shutdown, or other events resulting in the loss of environmental control.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Exterior Coating:
1. Chemline, Chemthane 2265
2. Futura Coatings, Protec II
3. Lifelast, Durashield 110, 210
4. Sherwin Williams, Corropipe 3000

B. Pneumatic Pull-Off Equipment for Test Coating Adhesion to Steel Substrates:
1. Delfesko, PosiTest AT-A

C. Holiday Testing:
1. Coating application plant testing equipment:
a. Tinker & Rasor, Model APS Holiday Detector
2. Field testing equipment:
a. Tinker & Rasor Model APS or M/1 Holiday Detector

D. DFT Testing:
1. DeFelsko
2. Elcometer

E. Power Tool Cleaning Equipment
1. MBX Bristle Blaster

2.2 MATERIALS

A. Coating Materials: Provide materials for coating holdbacks, welds, and other field application repair locations with Manufacturer-approved material.

B. Coating System:
1. In accordance with ASTM D 16 Type V primerless, two-component, quick-setting, 100% solids system free from VOCs and solvents, applied in accordance with AWWA C222. Maximum allowable elongation shall be 10%.
2. Independent coating performance testing report: Submit testing reports from an independent coating testing laboratory to the ENGINEER for approval in accordance with AWWA C222.

C. Coating Holdbacks and Repair: Repair coating holdbacks or repair areas with Manufacturer-approved product. Provide a letter of compliance from the Polyurethane Manufacturer approving primers and repair materials of a different Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. General:
1. Remove visible oil, grease, dirt, and contamination from the pipe/fitting surface in accordance with SSPC SP 1.
2. Remove metal slivers, sharp edges, burrs, weld splatter, gouges, delaminations, and other surface imperfections by filing or grinding prior to abrasive blasting in accordance with SSPC SP 2 and SSPC SP 3.
3. Protect prepared pipe/fitting from humidity and wet weather conditions. Flash rust, imperfections, or contamination on cleaned pipe surfaces shall be removed by re-blasting.
4. Complete priming and coating of the pipe/fitting surface within 1 day of surface preparation, or in accordance with Manufacturer recommendations.

B. Abrasive Blast Cleaning:
1. Compressors shall be in good working order and have adequate separators, filters, and drains to ensure contaminants such as oil and water are not deposited onto the steel surface. Accumulation of oil and moisture shall be removed by regular purging.
2. Abrasive blast surfaces shall be in accordance with SSPC SP 10/NACE No. 2 and obtain an angular anchor profile. An anchor pattern profile will be produced with a minimum average of 0.075 mm (3.0 mils). Individual measurements shall not be less than 0.065 mm (2.5 mils). Profile measurements shall be taken with replica tape and spring micrometer in accordance with NACE SP0287.
3. Abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion required.
4. Use abrasive free of debris and foreign matter.
5. Regularly check blasted surfaces in accordance with SSPC VIS 1 to ensure the proper surface finish is attained.
6. Check profile using replica tape and a spring micrometer at regular intervals in accordance with NACE SP0287.
7. Dry air blast or brush-off and vacuum blast surfaces to remove dust and debris prior to coating. Reblast any blasted surface showing flash rust stains prior to coating.
8. Cleanliness testing: Test pipe surface in accordance with ISO 8502-3, Part 3. Use pictorial references to ensure a cleanliness of 2.

3.2 INSTALLATION

A. Prepare and apply coatings in accordance with AWWA C222, SSPC PA 2, and as specified in the Manufacturer's PDS.
B. Minimum coating thickness shall be 25 mils.
C. Provide supplemental lighting as required to achieve an application area average of 50 foot-candles. No single point in the application area shall be less than 20 foot-candles of light.
D. Provide coating applied with good workmanship that is free of defects. Excessive orange peel, runs, sags, chips, holidays, blisters, or other defects may be cause for removal of the coating; abrasive blast and recoat as specified in this Section at the discretion of the ENGINEER.
E. Shop-Applied Coating:
    1. Equipment used for the coating application shall be in strict compliance with the Coating Manufacturer's recommendations.
    2. Ensure pipe surface temperature is at least 5°F above the dew point and within the Coating Manufacturer's recommended range.
    3. Perform the application of coating in an environmentally controlled shop area that meets or exceeds the environmental requirements of the Coating Manufacturer.
    4. Coating applied under improper environmental conditions will be rejected and shall be removed to bare metal and reapplied.
    5. Spray the pipe and the fitting using plural component spray equipment as recommended by the Coating Manufacturer to a minimum DFT as specified.
F. Field-Applied Coating:
    1. Prepare the bare steel as specified in this Section.
    2. Roughen the edge of shop coating as specified in this Section.
    3. Mask the surface to provide no more than 2 inches of overlap.
G. Coating Holdbacks and Field Installation:
    1. Exterior coating holdbacks for welding shall be field repaired with polyurethane as specified in this section, with epoxy as specified in SECTION 09 97 13.02, or a heat-shrinkable sleeve as specified in SECTION 09 97 13.05.
    2. Provide supplemental heat as required to ensure proper curing.
    3. Holdbacks as required for the proper jointing of pipe:
        a. Push-on joint, spigot: Flush with spigot end.
        b. Push-on, bell: Flush with end of bell for polyurethane coatings.
        c. Welded, spigot: 4 inches, minimum.
        d. Welded, bell: 4 inches, minimum.
    4. Ensure holdbacks are straight and cut through the full thickness of the coating that permits the field coating of joints in accordance with the Manufacturer's requirements.
H. Field Surface Preparation of Holdback Areas:
    1. Polyurethane Coating: Prepare metal surface of holdback areas with MBX Bristle Blaster or comparable device capable of providing and angular anchor profile.
        a. Prior to mechanical cleaning, use a hand tool to remove loose rust and scale and solvent clean to SSPC SP 1.
        b. Provide anchor profile of 2.5 mils to 3.3 mils for polyurethane materials.
        c. Provide anchor profile of 1.6 mils to 2.5 mils for epoxy materials.
        d. Using compressed air, clear grinding effluent and ensure there are no contaminants or loose material left on the surface.
    2. CML: Coat interior holdback with primer to prevent corrosion of the steel surface.
        a. Install primer within 1 day of surface preparation. If relative humidity rises above 85% at any point during installation, stop work.
        b. Ensure the primer is compatible with the joint coating system and is approved by the Manufacturer. Ensure compatibility with welding operations and that coating does not result in running or melting during welding operations.
        c. Conform to the Manufacturer's primer application and thickness recommendations; do not interfere with proper joint installation.
        d. Abrasive blast or bristle blast any corrosion within the holdback area in accordance with SSPC SP 10/NACE No. 2. Power tool cleaning shall be performed with the pneumatic bristle blaster capable of providing an angular anchor profile.
I. Wall Penetrations and Concrete Encasements:
    1. Extend coating through wall and floor penetrations.
    2. Extend coating a minimum of 12 inches into concrete encasements.

3.3 REPAIRS

A. Report any damage to coating to the ENGINEER.
    1. Weld spatter damage to coating from adjacent work shall be repaired for all visible areas.
B. Repair damaged coating in accordance with the Coating Manufacturer's recommendations.
C. Repair coating with detected holidays or containing visual damage. Any defect that indicates inadequate curing, component mixing, or surface preparation shall be cause for complete removal of the coating; abrasive blast and recoat as specified in this Section at the discretion of the ENGINEER.
D. Minor repairs, repairs less than 6 inches in the greatest dimension:
    1. Pinhole holidays, adhesion test repairs, and other minor repairs shall be repaired with Manufacturer-approved material.

2. Clean and feather the defect into the existing coating. Feather edges for a minimum of 2 inches around the defect. Apply repair material to the thickness recommended by the Manufacturer.

E. Major repairs, repairs exceeding 6 inches in the greatest dimension:
1. Feather existing coating.
2. Tape off coating adjacent to the repair area to prevent damage during repair. Remove defective coating and abrasive blast to provide a 2.5 mil minimum anchor profile that meets SSPC SP 10/NACE No. 2. Apply original coating material in accordance with this Section.

3.4 QUALITY CONTROL

A. General:
1. Provide QC testing with approved calibrated equipment.
2. Follow the most stringent Equipment Manufacturer recommendations for QC testing, including recommendations for attachments or appurtenances to testing equipment. Equipment size and type shall provide complete examination of the coating surface.

B. Inspection:
1. Inspect and test the coating system in accordance with AWWA C222 and the Contract Documents.
2. The ENGINEER may conduct random inspections and testing for final acceptance or rejection of the coating.
3. Perform a cleanliness test in accordance with ISO 8502-3 using the dust quantity rating meeting Class 2 or better.

C. Adhesion Testing:
1. Perform one adhesion test at the start of each production day and one subsequent random adhesion test during each production day on the applied coating. Do not perform further destructive testing on pipe or fittings intended for service without ENGINEER approval.
   a. The ENGINEER may request further adhesion testing if visual inspection shows an indication of application defects.
2. Perform testing under the supervision of a NACE Certified Coating Inspector in accordance with ASTM D 4541.
3. Adhesion records shall include, but not be limited to, pipe identification, surface tested, surface temperature, coating thickness, tensile force applied, mode of failure, and pass/fail identification in accordance with ASTM D 4541.
4. Allow dollies glued to the coating surface to cure in accordance with the Adhesive Manufacturer's recommendations. Score coating around the dolly prior to test.
5. Test coating adhesion to steel substrates using pneumatic pull-off equipment.
6. Adhesion to steel shall be 1,500 psi minimum tested in accordance with AWWA C222.
7. Failure:
   a. Adhesive failure: Separation of coating from steel substrate.
   b. Cohesive failure: Failure within the coating.
8. Failure of any pipe or fittings shall be cause for systematic testing of pipe and fittings in the same production period.

D. Holiday Testing:
1. Coating application plant testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage pulse tester in accordance with NACE SP0274.
2. Field testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage spark tester in accordance NACE SP0274. Coated piping and appurtenances shall be field holiday tested prior to installation. Conduct holiday testing in the presence of the ENGINEER and provide a minimum of 3 days notification ahead of testing.
   a. The minimum holiday testing voltage shall be no less than 100 V/mil times the maximum DFT gauge reading of the coating.
3. Repair holidays or defects in the coating as specified in this Section.
4. Conduct testing with properly sized wands, springs, or other attachments to provide testing for the entirety of the coated surface area.

E. DFT Testing:
1. Measure DFT in accordance with SSPC PA 2 with a properly calibrated magnetic gauge. Measurements below required minimum DFT shall be cause for systematic testing of the area. Coatings shall meet coating thickness restriction level 4, unless otherwise specified by the ENGINEER.
2. Conduct coating thickness measurements as necessary and without limitation. If applying different products, provide DFT for each applied coat prior to further coating application.

F. Final Field Testing Report:
1. Provide a final chronological testing report that includes:
   a. Locations of testing (stationing).
   b. Surface preparation information.
   c. DFT measurements.
   d. Changes, modifications, and alterations from plans.
   e. Comments relative to the Work.
   f. Failures and defects.
   g. Retesting information.

END OF SECTION

INTENTIONALLY BLANK

SECTION 09 97 13.02
LIQUID-EPOXY LININGS AND COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for liquid-epoxy linings and coatings.

B. Related Sections:

1. SECTION 09 90 00 – PAINTING AND COATING

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. C210 – Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings

B. ASTM International (ASTM):

1. D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

C. International Organization for Standardization (ISO):

1. 8502-3 – Preparation of Steel Substrates Before Application of Paints and Related Products – Tests for the Assessment of Surface Cleanliness – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)

D. NACE International (NACE):

1. SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
2. SP0274 – High-Voltage Electrical Inspection of Pipeline Coatings
3. SP0287 –Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

E. National Association of Pipe Fabricators (NAPF):

1. 500-03 – Surface Preparation Standard For Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

F. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

G. The Society for Protective Coatings (SSPC):

1. PA 2 – Determining Compliance to Required DFT
2. QP 1 – Field Industrial Contractor Qualification
3. SP 1 – Solvent Cleaning
4. SP 2 – Hand Tool Cleaning
5. SP 3 – Power Tool Cleaning
6. VIS 1 – Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast-Cleaning

H. The Society for Protective Coatings/NACE International (SSPC/NACE):

1. SP 10/NACE No. 2 – Near White Blast Cleaning

1.3 COORDINATION

A. Observation of Work:

1. Notify the ENGINEER in writing 14 days in advance of coating Work to allow for scheduling for shop or field observation. Notify the ENGINEER in writing a minimum of 3 days prior to actual surface preparation Work.
2. Allow the ENGINEER full access to the facilities and to appropriate documentation regarding the coating application.

1.4 SUBMITTALS

A. Product Data:

1. Catalog data and other information for proposed products.
   a. Provide product data for holdback and repair materials.
2. A copy of the Manufacturer's coating application QA manual.
3. NACE CIP Level 3 qualifications and written approval of coating application procedures and workmanship.

B. Submit the product application procedure, current PDS, SDS, and a copy of the QA/QC report for surface preparation and coating application. Include complete surface preparation and cleaning procedures, as well as application equipment. Include anchor profiles, DFT, adhesion tests, temperature, humidity, holiday tests, and any other measurements taken for QA/QC during surface preparation and application.

1. Submit QC data verifying the coating has been inspected and is free of defects prior to the transportation of coated pipe and appurtenances from the coating facility to the Work location.
2. Provide documentation that coating system DFT is in conformance with NSF/ANSI 61.

C. Provide a paint schedule that lists surface preparation, coating product, location, DFT, number of coats, and cure time.

D. Provide the ENGINEER with a copy of the coating application QA manual. Strict conformance to the manual requirements is required. Coating applied deviating from the requirements will be rejected. Rejected coating shall be removed and reapplied.

E. Field Applied Coatings: Provide complete environmental condition information taken before abrasive blasting or coating. Provide environmental data at 2-hour increments if prepared surface is not coated within 1 day. Information provided shall include temperature, relative humidity, location description, time, date, technician name, and company.

1. Submit photos for field application of coatings. Submit one photo of field-blasted surface prior to coating application for each area that is measured for anchor profile. Submit photos of each field applied coat prior to application of subsequent coats for each DFT measurement taken based on SSPC PA 2. Photos are not required for shop-applied coating application unless otherwise noted by the ENGINEER.

F. Submit the final field testing report to the ENGINEER within 2 weeks of the Substantial Completion date.

G. QC Testing Equipment:

1. Provide product data sheets for testing equipment for measuring DFT, holiday detection, and adhesion testing. Include information for any sensors, wands, springs, or other attachments used to provide QC testing.

2. Provide current calibration certificates for testing equipment updated within 6 months of the date of testing. Provide equipment settings required for testing based on the planned DFT of coating material.

1.5 QUALITY ASSURANCE

A. Provide certification by the Coating Manufacturer as an approved Applicator.

B. Coating Applicator:
   1. A minimum of 5 years of documented experience in the Work of this Section.
   2. A minimum of 5 years of documented experience in the application of coating and certification of attendance at the Coating Manufacturer's training class.
   3. Provide monitoring systems approved by the Manufacturer that constantly records pipe, fitting and coating conditions during the coating application. Recorded monitoring parameters include, but are not limited to, air temperature and humidity, pipe and fitting temperature, surface preparation, line speed, coating thickness, and holiday testing.
   4. SSPC QP 1 certification required for field coating applications.

C. Coating Manufacturer: Provide a representative trained and knowledgeable in technical aspects of the Manufacturer's products and systems available for technical support.

D. Coating Application:
   1. Surface preparation, application, and testing under the supervision of and approved by NACE CIP Level 3.
   2. Prepare surface and apply coating following the most stringent recommendations as specified in the Manufacturer's PDS.

E. NACE CIP Level 3:
   1. Provide name and contact information.
   2. Currently certified by NACE.
   3. Attend progress meetings as required.
   4. Oversee surface preparation and coating application.

F. Certify that lining for potable water lines is certified to NSF/ANSI 61.

G. Provide contrasting colors for primer, intermediate, and top coats.
   1. Provide finish colors as specified in SECTION 09 90 00.
      a. Recycled water piping coating: Pantone 2577U or ENGINEER-approved color.
      b. Potable water coating: Blue.
      c. Raw water: John Deere green.

H. Field Hold Points:
   1. For coatings and linings subject to immersion service, ENGINEER approval is required to continue work following finished surface preparation. Provide time for ENGINEER inspection of prepared surface and coating in accordance with SSPC PA 2.
   2. For coatings and linings subject to immersion service, ENGINEER approval is required after application of each coat and prior to application of the subsequent coat. Provide time for ENGINEER inspection of prepared surface and coating in accordance with SSPC PA 2.

I. QC: Testing shall be performed by the coating applicator, third-party inspector, or as approved by the ENGINEER.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle finished coated steel pipe in a manner that protects the pipe and the coating from damage.

B. Coated pipe shall not be dragged, pushed, dropped, or rolled on the ground. During handling and storage, ensure metal tools, tongs, chain slings, and equipment do not directly contact the coated pipe.

C. Store coated pipe in a manner that prevents damage to the pipe and coating in accordance with the Coating Manufacturer's recommendations.

D. Transportation: Damage to the liquid-epoxy coating during transportation shall be repaired in accordance with the Manufacturer's recommendations.

E. Packaging:
   1. Provide coating materials in the Manufacturer's original, unopened containers.
   2. Containers shall be plainly marked with the name and address of the Manufacturer, type of material, batch or lot number, date of manufacture, storage conditions, and information required by federal, state, and local regulations.

F. Storage:
   1. Store and protect materials from the elements; store in accordance with the Manufacturer's PDS.
   2. Maintain temperature ranges in the storage areas within the Manufacturer's recommended limits.
   3. Store or cover shop-applied materials in a manner to alleviate discoloration and chalking due to UV effects for materials stored longer than 6 months. If coated materials are stored in direct sunlight and show signs of chalking or other degradation, DFT measurements shall be performed to ensure adequate coating thickness is achieved prior to installation.

G. Do not use material that has exceeded the Manufacturer's storage stability period as specified in the PDS.

1.7 SITE CONDITIONS

A. General:
   1. Products shall comply with federal, state, and local requirements limiting the emission of VOCs and worker exposure to such compounds.
   2. Products shall comply with federal, state, and local air pollution requirements for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
   3. Abrasive blast cleaning or coating shall not be done when:
      a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the Coating Manufacturer.

b. There is a dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather conditions, or under conditions that could cause icing on metal surfaces.
c. Relative humidity exceeds 85% or it is expected that surface temperatures will drop below 5°F above the dew point within 2 hours after the coating application.

B. Temperature Control: In cold weather, prior to the coating application, if moisture collects on the pipe and the fitting surface, or if the temperature of the pipe and the fitting is less than 45°F, preheat pipe/fitting to a temperature of 50°F or 5°F above the dew point, whichever is greater.

C. Dehumidification and Heating:
1. Provide dehumidification and/or heating equipment when necessary for shop or field environmental control during surface preparation and coating application. Properly size equipment to maintain a dew point temperature at least 5ºF below the surface temperature of metal surfaces to be cleaned and coated.
2. Prevent cleaned metal surfaces from flash rusting and condensation or icing on the prepared surface throughout surface preparation and the coating application.
3. Provide properly trained personnel in the O&M of dehumidification equipment.
4. Reblast flash rusted metal surfaces and remove damaged coatings due to equipment malfunction, shutdown, or other events resulting in the loss of environmental control.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Interior Linings – Steel or DI Pipe:
1. AkzoNobel/Devoe, Bar-Rust 233H
2. Sherwin Williams, Sherplate PW, Macropoxy 646 PW, DuraPlate UHS
3. Tnemec, Series 20, Series 22, Series 140, Series 141, or FC 22

B. Interior Linings – DI Pipe:
1. Ceramic Epoxy: Induron, Protecto 401 (Recycled Water)
2. NSF/ANSI 61 Ceramic Epoxy: Induron, Ceramapure PL 90 (Potable Water)
3. Fusion-Bonded Epoxy: Axalta Coating Systems, Nap-Gard 7-0014

C. Exterior Coatings:
1. Sherwin Williams, Purple, Pantone 2577U, for recycled; blue or white for potable
2. Sherwin Williams, Macropoxy 646, SherPlate PW, DuraPlate UHS, DuraPlate 235
3. Tnemec, Series 20, Series 22, Series 140, Series 141, or FC 22

D. Pneumatic Pull-Off Equipment for Test Coating Adhesion to Steel Substrates:
1. Delfesko, PosiTest AT-A

E. Holiday Testing:
1. Coating application plant testing equipment:
a. Tinker & Rasor, Model APS Holiday Detector
2. Field testing equipment:
a. Tinker & Rasor Model APS or M/1 Holiday Detector

F. DFT Tester:
1. Elcometer
2. DeFelsko

G. Power Tool Cleaning Equipment
1. MBX Bristle Blaster

2.2 MATERIALS

A. Coating Materials: Products of a single Manufacturer. Provide materials for coating holdbacks, welds, and other field application repair locations with Manufacturer approved material.

B. Interior Pipe Lining System:
1. General:
a. Clean, prepare surface and apply in accordance with the Manufacturer's instructions.
b. Hold back lining 4 inches from the point at which the field weld is to be made.
c. Ends of lining shall be square and uniform.
d. Allow lining to cure completely for immersion service prior to shipping.
2. Apply material to a minimum DFT of 16 mils unless otherwise specified by the ENGINEER.
3. Independent coating performance testing report: Submit testing reports from a reputable independent coating testing laboratory to the ENGINEER for approval, in accordance with AWWA C210.
4. Linings and coatings: Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials used for the pipe. Coating and lining applied in this manner shall provide protection equal to that specified for the pipe.
5. Exposed metal surfaces except flanges shall be coated with the same material provided for the main line pipe.
6. Shop-applied liquid-epoxy lining:
a. Steel pipe shall be in accordance with AWWA C210.
b. NSF/ANSI 61 certified.
c. Prepare for immersion service.
d. Conduct low-voltage wet sponge testing in accordance with NACE SP0188 after the coating has reached cure. Any holidays detected will be marked and repaired.
7. Repairs: In accordance with the Manufacturer's recommendations.

C. Exterior Coatings:
1. Apply material on buried and submerged piping and appurtenances to a minimum DFT of 25 mils unless otherwise specified by the ENGINEER.
2. Steel pipe in accordance with AWWA C210.
3. Provide finish colors as specified in SECTION 09 90 00.
a. Two-part, low VOC, liquid-epoxy.
b. A aliphatic polyurethane may be applied to the coating to help alleviate discoloration or chalking prior to installation and is required for areas exposed to direct sunlight. The outer coat shall be applied within the time limits, surface conditions and temperatures recommended by the Manufacturer.
4. Repairs: In accordance with the Manufacturer's recommendations.
5. Piping in vaults: As specified in SECTION 09 90 00.

PART 3 EXECUTION

3.1 GENERAL

A. Flanges: The inside of blind flanges shall be coated with 16 mils of liquid-epoxy in accordance with AWWA C210. Do not coat flange gasket sealing surfaces.

3.2 PREPARATION

A. General:
1. Remove visible oil, grease, dirt, and contamination from the pipe and the fitting surface in accordance with SSPC SP 1.
2. Remove metal slivers, sharp edges, burrs, weld splatter, gouges, delaminations, and other surface imperfections by filing or grinding prior to abrasive blasting in accordance with SSPC SP 2 and SSPC SP 3.
3. Protect the prepared pipe and fitting from humidity and wet weather conditions. Flash rust, imperfections, or contamination on cleaned pipe surfaces shall be removed by reblasting.
4. Complete priming and coating of the pipe and the fitting surface the same day as surface preparation.

B. Abrasive Blast Cleaning:
1. Abrasive blast steel surfaces to be coated in accordance with SSPC SP 10/NACE No. 2 and obtain a 3 mil to 4 mil angular anchor profile.
2. Abrasive blast DI surfaces to be coated in accordance with NAPF 500-03.
3. Abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion required.
4. Use abrasives free of debris and foreign matter.
5. Regularly check blasted surfaces in accordance with the SSPC VIS 1 to ensure the proper surface finish is attained.
6. Check profile using replica tape and a spring micrometer at regular intervals in accordance with NACE SP0287.
7. Dry air blast or brush-off and vacuum blast surfaces to remove dust and debris prior to coating. Reblast any blasted surface showing flash rust stains prior to coating.
8. Cleanliness testing: Test pipe surface in accordance with ISO 8502-3, Part 3. Use pictorial references to ensure a cleanliness of 2.

3.3 INSTALLATION

A. Prepare and apply lining and coatings for steel pipe in accordance with AWWA C210, the Coating Manufacturer's recommendations, and this Section, whichever is more stringent.

B. Provide supplemental lighting as required to achieve an application area average of 50 foot-candles. No single point in the application area shall be less than 20 foot-candles of light.

C. Provide coating applied with good workmanship that is free of defects. Excessive orange peel, runs, sags, chips, holidays, blisters, or other defects may be cause for removal of the coating; abrasive blast and recoat as specified in this Section at the discretion of the ENGINEER.

D. Shop-Applied Coating:
1. Equipment used for the coating application shall be in strict compliance with the Coating Manufacturer's recommendations.
2. Ensure pipe surface temperature is between 50°F and 100°F and at least 5°F above the dew point, unless approved by the Coating Manufacturer.
3. Perform the application of coating in an environmentally controlled shop area that meets or exceeds the environmental requirements of the Coating Manufacturer.
4. Coating applied under improper environmental conditions shall be rejected and removed to bare metal and reapplied.
5. Spray the pipe and the fitting using plural component spray equipment as recommended by the Coating Manufacturer to a minimum DFT as specified.

E. Coating Holdback:
1. Holdbacks as required for the proper jointing of pipe:
a. Push-on joint, spigot: Flush with spigot end.
b. Push-on, bell: Flush with end of bell.
c. Welded, spigot: 4 inches, minimum.
d. Welded, bell: 4 inches, minimum.
2. Ensure holdbacks are straight and cut through the full thickness of the coating that permits the field coating of joints in accordance with the Manufacturer's requirements.
3. Coat holdback with primer to prevent corrosion of the steel surface:
a. Ensure the primer is compatible with the joint coating system and with welding operations and shall not result in running or melting during welding operations.

b. Conform to the Manufacturer's primer application and thickness recommendations; do not interfere with proper joint installation.
c. Abrasively blast any corrosion within the holdback area in accordance with SSPC SP 10/NACE No. 2 or a power tool and clean with MBX Bristle Blaster to provide adequate anchor profile.

F. Lining and Coating:
1. Stripe coat surfaces with sharp angles, edges, and corners prior to spray application.
2. The joint recess shall be free of mud, oil, weld flux, weld splatter, and other foreign contaminants.
3. Joint recess shall then be abrasive-blasted, vacuum-blasted, or abraded using rotary abrading pads to provide a surface that is in accordance with SSPC SP 10/ NACE No. 2.
4. Feather the adjacent liquid-epoxy coating by abrading the surface for a minimum distance of 2 inches.
5. Steel temperature: A minimum of 5°F above the dew point.
6. Mixed lining material temperate: A minimum of 50°F or the Manufacturer's recommendations.
7. Apply and allow to cure in accordance with AWWA C210 and the Manufacturer's recommendations.
8. Provide a certification of a holiday free field joint lining or coating to the OWNER.

3.4 REPAIRS

A. Report any damage to the coating or lining to the ENGINEER. Weld spatter damage to coating from adjacent work shall be repaired for all visible areas.

B. Repair damaged coating in accordance with the Coating Manufacturer's recommendations. Repair steel pipe in accordance with AWWA C210.

C. Repair coating with detected holidays or containing visual damage. Any defect that indicates inadequate curing, component mixing, or surface preparation shall be cause for complete removal of the coating, abrasive blast and recoat as specified in this Section at the discretion of the ENGINEER.

D. Pinhole holidays, adhesion test repairs, and other minor repairs shall be made with the Manufacturer's approved repair materials.

E. Clean and repair the defect in accordance with the Manufacturer's recommendations using an MBX Bristle Blaster or comparable device capable of producing an anchor profile of 1.5 mils, minimum. Roughen the existing coating and feather edges for a minimum of 2 inches around the defect. Apply repair material to a thickness recommended by the Manufacturer.

F. Other:
1. Areas not accessible, such as small diameter pipe, shall be reprocessed and recoated in accordance with AWWA C210.
2. Repairs shall be holiday tested.

3.5 QUALITY CONTROL

A. Inspection:
1. Inspect and test the coating system in accordance with AWWA C210 and the Contract Documents.
2. The ENGINEER may conduct random inspections and testing for final acceptance or rejection of coating.
3. Perform cleanliness test in accordance with ISO 8502-3 using the dust quantity rating meeting Class 2 or better.
4. Provide time for ENGINEER inspection of prepared surface and coating as specified in SSPC PA 2. Do not backfill pipe without ENGINEER approval following field coating application.
5. Provide QC testing with approved calibrated equipment.
6. Follow the most stringent Equipment Manufacturer recommendations for QC testing, including recommendations for attachments or appurtenances to testing equipment. Equipment size and type shall provide complete examination of the coating surface.

B. Adhesion Testing:
1. Perform testing by a NACE certified coating inspector in accordance with ASTM D 4541.
2. Randomly select a minimum of 10% of sufficiently cured coated pipe lengths and fittings to be tested from each lot of pipe.
3. A pipe lot is defined as the quantity of pipe coated by a single crew within a Work shift.
4. Adhesion records shall include, but not be limited to, pipe identification, surface tested, surface temperature, coating thickness, tensile force applied, mode of failure, and pass/fail identification.
5. Allow dollies glued to the coating surface to cure in accordance with the Adhesive Manufacturer's recommendations. Score coating around the dolly prior to test.
6. Test coating adhesion to steel substrates using pneumatic pull-off equipment.
7. Coating shall have an adhesion to steel of 800 psi, minimum.
8. Repair coating damage from testing as specified in this Section.
9. Failure:
a. Adhesive failure: Separation of coating from steel substrate.
b. Cohesive failure: Failure within the coating.
10. Failure of any pipe or fittings within a pipe lot shall be cause for systematic testing of pipe and fittings in the lot.
11. Repair damaged areas of accepted pipe/fitting coating.
12. Randomly select repair patches for adhesion testing.

C. Holiday Testing:
1. Coating application plant testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage spark tester in accordance with NACE SP0188. Coatings or linings that exceed 20 mils DFT shall be holiday tested in accordance with NACE SP0274.

2. Field testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage spark tester or a low-voltage wet sponge tester in accordance with NACE SP0188 prior to installation. Conduct holiday testing in the presence of the ENGINEER and provide a minimum of 3 days notification ahead of testing.
    a. The dielectric value of air shall be considered 100 V/mil. The minimum holiday testing voltage shall be no less than the value calculated using the dielectric value of air times the maximum measured DFT of the coating or lining.
3. Repair holidays or defects in the coating as specified in this Section.
4. Epoxy lined pipe:
    a. Holiday test epoxy lined pipe and appurtenances following installation, joint repair, and other work that could damage the interior lining.
5. Conduct testing with properly sized wands, springs, or other attachments to provide testing for the entirety of the coated surface area.

D. DFT Testing:
1. Measure DFT in accordance with SSPC PA 2 with a properly calibrated magnetic gauge. Coatings and linings shall meet coating thickness restriction level 4, unless otherwise specified by the ENGINEER.
2. Conduct coating thickness measurements as necessary and without limitation.
    a. If applying different products, provide DFT for each applied coat prior to further coating application.
3. The ENGINEER may conduct random DFT testing, and may identify individual areas

E. Final Field Testing Report:
1. Provide a final chronological testing report that includes:
    a. Locations of testing (stationing).
    b. Surface preparation information.
    c. DFT measurements.
    d. Changes, modifications, and alterations from plans.
    e. Comments relative to the Work.
    f. Failures and defects.
    g. Retesting information.

END OF SECTION

SECTION 09 97 13.03
CEMENT MORTAR LININGS AND COATINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for cement mortar linings and coatings.

1.2 REFERENCES
- A. American Water Works Association (AWWA):
  1. C205 – Cement-Mortar Protective Lining and Coating for Steel Water Pipeline, 4 In. (100 mm) and Larger – Shop Applied
- B. The Society for Protective Coatings (SSPC):
  1. SP 2 – Hand Tool Cleaning
  2. SP 3 – Power Tool Cleaning

1.3 COORDINATION
- A. Observation of Work:
  1. Notify the ENGINEER in writing 14 days in advance of coating Work to allow for scheduling for shop or field observation. Notify the ENGINEER in writing a minimum of 3 days prior to actual surface preparation Work.
  2. Allow the ENGINEER full access to the facilities and to appropriate documentation regarding the coating application.

1.4 SUBMITTALS
- A. Product Data:
  1. Material lists including materials to be utilized, including source.
  2. Mix design for mortar.
  3. Source, type, and Manufacturer data on proposed admixtures or additives.
  4. Manufacturer data on bonding agent.
  5. Material specifications, material data sheets, and instructions for curing compound and any solvent used to clean the pipe prior to lining.
  6. Test reports and certificates:
     a. Mill test report for reinforcing wire, wire mesh, welded wire fabric.
     b. Final shop testing report.
  7. Procedures and description of methods of lining, coating, curing, and protecting pipe and fittings. Include equipment to be used, operational procedures, curing procedures and equipment, description of method and procedure to ensure thickness and density or the lining or coating.

1.5 QUALITY ASSURANCE
- A. Coating Applicator:
  1. A minimum of 2 years documented experience in the Work of this Section.
  2. The application method and type of machinery shall have been used successfully for similar work for a period of 5 years. The machine used for centrifugal lining shall have been used successfully for similar work, be approved by the ENGINEER, and have been shown capable of handling pipe of the size and type required.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. Do not use material that has exceeded the Manufacturer's specified storage stability period.
- B. Protect linings and coatings from damage during handling, transporting, and erection of pipe. Damaged portions of the lining or coatings shall be restored to original condition. Field-applied lining or coating found to be damaged or not acceptable to the ENGINEER shall be removed and replaced.
- C. Storage:
  1. Store and protect process materials and finished pipe from the elements as necessary.
  2. Maintain temperature and moisture ranges in the storage areas within the Manufacturer's recommended limits and in accordance with AWWA C205.

PART 2 PRODUCTS

2.1 MATERIALS
- A. Cement, aggregate, water, reinforcement, curing, admixtures, and mix design shall be in accordance with AWWA C205.
  1. Admixtures, bonding agents, or other additives shall be NSF 61 certified.
  2. Reinforcement:
     a. Spiral wire, wire fabric, or wire mesh.
     b. Free of oil, grease, and other contaminants that might reduce the bonding between the coating and reinforcement.
     c. Placed in the middle third to half of the coating thickness.
- B. Interior Linings:
  1. General:
     a. Apply in accordance with the AWWA C205, including surface cleaning, preparation, and thickness.
     b. Hold back lining 2 1/2 inches from the point at which the field weld is to be made.
        1) Leave ends of lining square and uniform.
        2) Allow lining to cure completely prior to shipping.
        3) Exposed metal surfaces except flanges shall be coated with the same material provided for the main line pipe.

2. Except as otherwise provided in AWWA C205, clean and line the interior surfaces of steel pipe, fittings, and specials in the shop with CML applied centrifugally in accordance with AWWA C205.
    a. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application using the same materials used for the pipe. Lining and coating applied in this manner shall provide protection equal to that specified for the pipe.
3. Leave the pipe bare where field joints occur as shown on the Drawings. Feathered or uneven edges will not be permitted.
4. Regulate the progress of the application of CML in order that hand work, including the repair of the defective areas and the removal of the outlet stoppers and covers, is completed and cured in accordance with AWWA C205. Use the same cement mortar for patching that was used for machine lining. Use of a finer grading of sand and mortar richer in cement can be used when field inspection indicates that such a mix will improve the finished lining of the pipe.

C. Exterior Coatings:
1. In accordance with AWWA C205.
2. Minimum thickness: 1 inch.
3. Cement mortar: Not more than 3 to 1 sand to cement by weight.
4. Moisture content: Not less than 7% of the total dry weight of the mix.
5. Hold back: 5 inches, minimum.
6. Ends of coating: Square and uniform.
7. Pipe: Uncoated at field joints as shown on the Drawings.
8. Cement mortar coating: Applied by mechanical or pneumatic placement to the specified thickness.

PART 3 EXECUTION

3.1 PREPARATION

A. General:
1. Prepare and apply coatings and linings in accordance with AWWA C205 and as specified in this Section, whichever is more stringent.
2. Remove visible oil, grease, dirt, and contamination from the pipe and the fitting surface in accordance with SSPC SP 2 and SSPC SP 3. Immediately prior to the application of the mortar lining, the interior surfaces shall be cleaned of any material that may have accumulated after the initial cleaning.
3. The finished surface shall be uniformly smooth with no trace of sand or gritty particles. If the resulting finish is not equivalent to a steel trowel finish, it shall be given a steel trowel finish. A second troweling shall be done if the first fails to provide an acceptable smooth, hard-finish surface.
    a. Remove defective material, as determined by the ENGINEER, and replace to the full thickness required.
    b. Cut back defective linings to a square shoulder to avoid feather-edged joints.
4. Take every precaution to prevent damage to the lining. If the lining is damaged or found faulty at the delivery site, replace the damaged or unsatisfactory portions with lining in accordance with the Contract Documents.

3.2 INSTALLATION

A. Shop-Applied Coating:
1. The Applicator shall be present during coating application Work and shall be responsible for controlling aspects of the Work.
2. Perform the application of coating in an environmentally controlled shop area that meets or exceeds the environmental requirements of the Coating Manufacturer.
3. Coating applied under improper environmental conditions will be rejected and shall be removed to bare metal and reapplied.

B. Field Joint Lining:
1. The joint recess shall be free of mud, oil, weld flux, weld splatter, and other foreign contaminants.
2. Use material for the mortar lining in accordance with AWWA C205, Appendix A.
3. At welded joints, provide self-furred welded wire fabric, tack welded to the inside of the joint prior to application of mortar as shown on the Drawings.
4. With the approval of the ENGINEER, a water-based acrylic bonding agent may be used in place of the welded wire fabric.
5. Apply the mortar with a uniform pressure producing a smooth surface and a uniform thickness of the lining to match the shop-applied mortar lining.
6. At no point shall there be an indentation or projection that exceeds 1/16 inch.

C. Field-Applied Coating:
1. The site shall be free of mud, oil, weld flux, weld splatter, and other foreign contaminants.
2. In accordance with AWWA C205.
3. Cement mortar shall be not more than 3 to 1 sand to cement by weight. The mixture shall be moistened with sufficient clean water to permit packing and trowelling without crumbling.
4. Joints and exposed steel pipe shall be thoroughly cleaned and wetted to ensure a good bond prior to placement. Clearing shall be by wire brush, water blasting, or other method approved by the ENGINEER.
5. Water impermeable bands or diapers shall be used to retain the cement mortar to bridge the joint.

3.3 REPAIRS

A. In accordance with AWWA C205.
B. Repairs that require extensive chipping or routing of the cracks shall be avoided.

3.4 QUALITY CONTROL

A. Inspection:
   1. Inspect and test the coating system in accordance with referenced standards and the Contract Documents.
   2. The ENGINEER may conduct random inspections and testing for final acceptance or rejection of coating.

B. Final Shop Testing Report:
   1. Provide a final chronological testing report that includes:
      a. Locations of testing, stationing.
      b. Changes, modifications, and alterations from plans.
      c. Comments relative to the Work.
      d. Failures and defects.
      e. Retesting information.

END OF SECTION

INTENTIONALLY BLANK

SECTION 09 97 13.04
WAX TAPE COATINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for wax tape coatings.

1.2 REFERENCES
- A. American Water Works Association (AWWA):
  1. C217 – Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings
- B. NACE International (NACE):
  1. SP0375 – Field-Applied Underground Wax Coating Systems for Underground Metallic Pipe: Application, Performance, and Quality Control
- C. The Society for Protective Coatings (SSPC):
  1. SP 2 – Hand Tool Cleaning

1.3 SUBMITTALS
- A. Product Data: Manufacturer's catalog data for each item; include the Manufacturer's name and provide sufficient information to show that materials meet the requirements of the Contract Documents.

1.4 QUALITY ASSURANCE
- A. Provide the Manufacturer's certification that material components meet the requirements of the Contract Documents; include references for the applicable Sections and Standard Details.
- B. Provide the Manufacturer's stamp on material components.
- C. Material, fabrication, and installation are subject to inspection and testing by the ENGINEER.
- D. Products shall be installed by personnel trained by the Manufacturer or as approved by the ENGINEER.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Wax Tape Coating:
  1. Denso North America, Denso Paste
  2. The Trenton Corporation, Trenton Wax-Tape Primer
- B. Wax Tape for Buried Applications:
  1. Trenton Wax-Tape #1
- C. Wax Tape for Above Ground Applications:
  1. Densyl Tape
  2. Trenton Wax-Tape #2
- D. Mastic:
  1. Denso North America, Denso Densyl Mastic
  2. The Trenton Corporation, Trenton Fill-Pro PM-GP
- E. Tape Outerwrap:
  1. Denso North America, Denso Poly-Wrap
  2. The Trenton Corporation, Trenton Poly-Ply

2.2 MATERIALS
- A. Primer:
  1. Description: Blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency.
  2. Properties:
     a. Denso paste: Flash point: 356°F, minimum.
     b. Trenton wax-tape primer:
        1) Pour point: 100°F to 115°F.
        2) Flash point: 350°F, minimum.
- B. Mastic:
  1. Description: Cold-applied, self-adhesive, moldable, and self-supporting petrolatum and polymer based mastic for sealing and filling metal substrates, irregular shaped fittings, couplings, and other areas difficult to yield a smooth surface.
  2. Properties:
     a. Densyl mastic: Flash point: 356°F, minimum.
     b. Trenton Fill-Pro PM-GP:
        1) Application temperature: 0°F to 110°F.
        2) Flash point: 350°F, minimum.
- C. Wax Tape:
  1. Description: Plastic-fiber felt, saturated with a blend of petrolatums, plasticizers, and corrosion inhibitors forming a tape coating that is easily formable over irregular surfaces.
  2. Properties:
     a. Color:
        1) Potable water pipe: Brown.
        2) Recycled water pipe: Purple.
     b. Saturant pour point: 115°F to 125°F.
     c. Thickness: Minimum 46 mils.
     d. Tape width: 6 inches.
     e. Dielectric strength: 170 V/mil.

D. Tape Outerwrap:
   1. Description: PVC plastic with three, 50 gauge plies wound together as a single sheet.
   2. Properties:
      a. Color: Clear.
      b. Thickness: 1.5 mils.
      c. Dielectric strength: 2,000 V/mil.
      d. Tape width: 6 inches.
      e. Water absorption: Negligible.

PART 3 EXECUTION

3.1 INSTALLATION

A. Wax Tape Coating:
   1. Coat buried flanges, couplings, valves, uncoated pipe, and fittings in blowoff, access, and air valve manholes with a three-part, cold-applied wax tape coating system consisting of primer, wax tape, and tape outerwrap in accordance with NACE SP0375 and AWWA C217. For voids, irregular shaped fittings, contours, and crevices on couplings, joints, or valves, an optional filling mastic may be applied between the primer and the wax tape. Do not coat corporation stop threads, air valve openings, or other parts of appurtenances that impede the intended use.
   2. Coat DI pipe, flanges, couplings, and valves in manholes and vaults not equipped with a sump pump, or that are susceptible to submersion.
   3. Ensure surfaces are free from loose rust, scale, paint, dirt, and other foreign matter in accordance with SSPC SP 2.
   4. Apply wax tape primer by hand or brush to the surfaces of flanges, valves, pipes, or fittings.
   5. Vigorously work primer into surface and crevices, around studs and nuts, and completely cover exposed metal surfaces.
   6. Extend primer a minimum of 3 inches onto adjacent surfaces of the pipe.
   7. Apply mastic by hand, working material on to metal to displace moisture and ensure adhesion. Continue to apply material in and around voids, contours, and crevices to build up an even surface.
   8. Apply wax tape immediately after primer and mastic application:
      a. Cut short lengths of tape and place around each bolt head and nut.
      b. Work tape into crevices around studs and nuts.
      c. Wrap wax tape spirally around the pipe and across flanges and valves to the opposite side of the pipe.
      d. Cover the entire primed area with wax tape using a minimum overlap of 55% of the tape width.
      e. Work tape into crevices and contours of irregular shaped surfaces and smooth out to obtain a continuous protective layer with no voids or spaces under the tape.
   9. Apply tape outerwrap to wax tape installation:
      a. Wrap spirally around the pipe, couplings, and across flanges and valves.
      b. Extend plastic wrap a minimum of 3 inches beyond the wax tape using a minimum overlap of 55% of the plastic material width to apply two layers of overwrap.

END OF SECTION

SECTION 09 97 13.05
HEAT-SHRINK COATINGS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for heat-shrink coatings.

1.2 REFERENCES
- A. American Water Works Association (AWWA):
  1. C216 – Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
- B. NACE International (NACE):
  1. SP0274 – High-Voltage Electrical Inspection of Pipeline Coatings
- C. The Society for Protective Coatings (SSPC):
  1. SP 3 – Power Tool Cleaning

1.3 SUBMITTALS
- A. Product Data: Manufacturer's catalog data for each item; include the Manufacturer's name and provide sufficient information to show that materials meet the requirements of the Contract Documents.

1.4 QUALITY ASSURANCE
- A. Provide the Manufacturer's certification that materials components meet the requirements of the Contract Documents; include references for the applicable Sections and Standard Details.
- B. Provide the Manufacturer's stamp on materials components.
- C. Materials, fabrication, and installation are subject to inspection and testing by the ENGINEER.
- D. Products shall be installed by personnel trained by the Manufacturer or as approved by the ENGINEER.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Canusa-CPS
- B. Covalence
- C. Tinker & Rasor, Model APS Holiday Detector

2.2 MATERIALS
- A. Heat-Shrink Coating:
  1. Coat buried push-on and welded joints with a two-layer heat-shrink coating system in accordance with AWWA C216 Type I or Type II:
     a. Layer 1: Heat-activated sealant adhesive.
     b. Layer 2: Cross-linked polyolefin backing.
     c. Type I: Tubular type installed prior to joining the pipe ends.
     d. Type II: Wraparound type wrapped circumferentially around the area to be coated; include a separate or pre-attached closure to secure overlap during heating.
     e. Thickness: 60 mils, minimum.
     f. Width: 2 inch overlap on existing coating, minimum.
  2. Provide a heat-shrink sleeve compatible with the existing coating in accordance with the Manufacturer's recommendations.
  3. Consider sleeve shrinkage during heating in determining sizing.
  4. Filler:
     a. At joint locations with a step-down a moldable mastic filler may be required prior to the application of the heat-shrink coating.
     b. The maximum step-down size allowed without mastic filler shall be specified by the Heat-Shrink Coating Manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Heat-Shrink Coating:
  1. Coat buried push-on and inline weld joints with a two-layer heat-shrink coating system in accordance with local government regulations and standard safety practices.
     a. Do not weld at heat-shrink sleeve locations following sleeve installation.
  2. Material equipment:
     a. Appropriately sized sleeve.
     b. Closure patch.
     c. Torch.
     d. Propane gas tank.
     e. Hose.
     f. Regulator.
     g. Gauge.
  3. Provide surfaces that are free from rust, scale, paint, dirt, and other foreign matter in accordance with SSPC SP 3.
  4. Type I:
     a. Install sleeve over the pipe prior to joining the pipe ends.
     b. Preheat the surface until hot to hand, approximately 140°F minimum on a pipe 16 inches and smaller in diameter. For pipe sizes 16 inches and larger in diameter, use two people on the opposite sides of the pipe to heat concurrently.
     c. Remove protective release plastic from sleeve.

d. Slide sleeve over the joint and center.
e. The sleeve shall overlap the existing pipe coating evenly with a minimum of 2 inches on either side.
f. Using a torch and beginning at the center of the sleeve, heat the sleeve circumferentially around the pipe in a constant paintbrush motion until the sleeve surface is smooth.
g. Continue heating toward one end of the sleeve, followed by the other.
h. During shrink-down (sleeve recovery), occasionally check adhesive flow with a gloved finger to ensure proper adhesion to the pipe surface.
i. Sleeve recovery is complete when:
    1) Surface is smooth.
    2) Surface has no clod spots.
    3) Weld bead profile can be seen.
    4) Mastic flow is evident on both edges.
    5) Fully conformed to pipe and existing coating.

5. Type II:
    a. Cut sleeve to the proper length in accordance with the Manufacturer's recommendations.
    b. Cut the corners of the underlying end of the sleeve to approximately 1/2 inch by 2 inches.
    c. Preheat the surface until it is hot to the hand, approximately 140°F minimum, on pipe that is 16 inches and smaller in diameter. For pipe sizes 16 inches and larger in diameter, use two people on opposite sides of the pipe to heat concurrently.
    d. Remove protective release plastic from sleeve.
    e. Center the sleeve over the joint evenly so it overlaps the existing coating a minimum of 2 inches on either side.
    f. Overlapping sleeve ends shall align evenly.
    g. Center closure in position and press over the exposed sleeve end.
    h. The sleeve ends shall overlap a minimum of 2 inches.
    i. Using a torch, heat the closure evenly until the pattern of fabric reinforcement is visible.
    j. With a gloved hand, smooth wrinkles from the center outward.
    k. Begin heating the center of the sleeve circumferentially around the pipe in a constant paintbrush motion until the surface is smooth.
    l. Continue heating toward one end of sleeve, followed by the other.
    m. During shrink-down (sleeve recovery), occasionally check adhesive flow with a gloved finger to ensure proper adhesion to the pipe surface.
    n. Press or roll the closure and overlap area while hot to remove air voids.
    o. Sleeve recovery is complete when:
        1) Surface is smooth.
        2) Surface has no cold spots.
        3) Weld bead profile can be seen.
        4) Mastic flow is evident on both edges.
        5) Fully conformed to pipe and existing coating.

6. Coating repair: Repair holidays and defects in the coating in accordance with the Manufacturer's recommendations.

3.2 PROTECTION

A. No metal tools or heavy objects shall come into contact with finished heat-shrink coating.
B. Avoid walking on heat-shrink coating.
C. Pipe shall be backfilled in a manner that prevents damage to heat-shrink coating.
D. Backfill shall be placed around the heat-shrink coating only after the final inspection has been made and the coating has been approved.

3.3 QUALITY CONTROL

A. Perform adhesion testing in accordance with AWWA C216. One out of every ten sleeves shall be tested, and the ENGINEER may select test areas.
B. Conduct holiday testing in accordance with NACE SP0274.

END OF SECTION

SECTION 09 97 13.06
TAPE AND VISCOELASTIC COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for tape and viscoelastic coatings.

1.2 REFERENCES

A. American Water Works Association (AWWA):
   1. C209 – Tape Coatings for Steel Water Pipe and Fittings
   2. C214 – Tape Coating Systems for Steel Water Pipe
   3. C216 – Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
   4. C217 – Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings
   5. C225 – Fused Polyolefin Coating Systems for Steel Water Pipe

B. ASTM International (ASTM):
   1. D 4417 – Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

C. International Organization for Standardization (ISO):
   1. 8502-3 – Preparation of Steel Substrates Before Application of Paints and Related Products – Tests for the Assessment of Surface Cleanliness – Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)

D. NACE International (NACE):
   1. SP0188 – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
   2. SP0287 –Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

E. Society of Protective Coatings (SSPC):
   1. AB 1 – Mineral and Slag Abrasives
   2. AB 3 – Ferrous Metallic Abrasive
   3. SP 1 – Solvent Cleaning
   4. SP 2 – Hand Tool Cleaning
   5. SP 3 – Power Tool Cleaning
   6. VIS 1 – Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

F. The Society for Protective Coatings/NACE International (SSPC/NACE):
   1. SSPC SP 6/NACE No. 3 – Commercial Blast Cleaning

1.3 COORDINATION

A. Observation of Work:
   1. Notify the ENGINEER in writing 14 days in advance of any coating Work to allow for scheduling of shop or field observation. Notify the ENGINEER in writing a minimum of 3 days prior to actual Work.
   2. Allow the ENGINEER full access to facilities and appropriate documentation regarding the coating application.

1.4 SUBMITTALS

A. Product Data:
   1. Catalog data and other information for the proposed products.
   2. A copy of the Manufacturer's coating application quality assurance manual.
   3. NACE CIP Level 3 qualifications.

B. Submit a final chronological testing report to the ENGINEER within 2 weeks of the Substantial Completion date.

1.5 QUALITY ASSURANCE

A. Provide certification of an approved applicator status by the Coating Manufacturer.

B. Coating Applicator Qualifications: Minimum of 5 years of documented experience in the Work of this Section.

C. The Coating Manufacturer shall provide a representative trained and knowledgeable in the technical aspects of the Manufacturer's products and systems available for technical support when requested by the ENGINEER.

D. Field Coating Testing: Testing performed by or under the supervision of a NACE CIP Level 3 or higher.

E. NACE CIP Level 3 Qualifications:
   1. Provide name and contact information.
   2. Currently certified by NACE.
   3. Attend progress meetings as required.

F. Outer Layer/Outerwrap Tape Color:
   1. Recycled water piping: Pantone 2577U.
   2. Other: White.
   3. DIA: Pantone 305C.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle finished coated steel pipe in a manner that protects the pipe and the coating from damage.

B. Coated pipe shall not be dragged, pushed, dropped, or rolled on the ground. During handling and storage, ensure metal tools, tongs, chain slings, and equipment do not contact the coated pipe.

C. Handle coated pipe using a crane with end hooks or a forklift with padded blades.

D. Store coated pipe in a manner that prevents damage to the pipe and coating in accordance with the Coating Manufacturer's recommendations.

E. Transportation:
   1. Roll coated pipe off the forklift blades onto the truck trailer in a manner that prevents damage to the pipe and the coating. The trailer bed shall be clean and free from foreign matter that may cause pipe and coating damage. Pad load bearing surfaces on the trailer bed.

2. Secure pipe on the trailer bed using sufficient shoring, dunnage, padding, and banding prior to transporting.
3. Support pipe at the jobsite in a sufficient manner to prevent damage to the pipe and the coating.

F. Packaging:
1. Provide coating materials in the Manufacturer's original, unopened containers.
2. Containers shall be plainly marked with the name and address of the Manufacturer, type of material, batch or lot number, date of manufacture, storage conditions, and information required by federal, state, and local regulations.

G. Storage of Tape Coatings:
1. Store and protect materials from the elements; store in accordance with the Manufacturer's recommendations.
2. Maintain temperature ranges in the storage areas within the Manufacturer's recommended limits.
3. Store or cover shop-coated materials in a manner to alleviate discoloration and chalking due to UV effects.

H. Storage of Viscoelastic Products:
1. Material shall be suitable for storage at ambient temperatures ranging up to 104°F with 90% humidity.
2. Stored indoor, clean and dry, away from direct sunlight below 113°F.

I. Do not use material that has exceeded the Manufacturer's specified storage stability period.

1.7 SITE CONDITIONS

A. General:
1. Products shall comply with federal, state, and local requirements limiting the emission of VOCs and worker exposure to such compounds.
2. Products shall comply with federal, state, and local air pollution requirements for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
3. Abrasive blast cleaning or coating shall not be done when:
a. Surface and ambient temperatures exceed the maximum or minimum temperatures recommended by the Coating Manufacturer.
b. There is a dust or smoke-laden atmosphere, blowing dust or debris, damp or humid weather conditions, or under conditions that could cause icing on metal surfaces.
c. Relative humidity exceeds 85% or it is expected that surface temperatures will drop below 5°F above the dew point within 2 hours after the coating application.

B. Temperature Control: In cold weather, prior to the coating application, if moisture collects on the pipe and the fitting surface, or if the temperature of the pipe and the fitting is less than 45°F, preheat pipe/fitting to a temperature of 50°F or 5°F above the dew point, whichever is greater.

C. Dehumidification:
1. Provide dehumidification equipment when necessary for shop or field environmental control during surface preparation and coating application. Properly size dehumidification equipment to maintain a dew point temperature at least 5ºF below the surface temperature of metal surfaces to be cleaned and coated.
2. Prevent cleaned metal surfaces from flash rusting and condensation or icing on the prepared surface throughout surface preparation and the coating application.
3. Provide properly trained personnel in the O&M of dehumidification equipment.
4. Reblast flash rusted metal surfaces and remove damaged coatings due to equipment malfunction, shutdown, or other events resulting in the loss of environmental control.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Polyken
B. Stopaq
C. Tapecoat
D. Holiday Testing Equipment:
1. Coating application plant testing equipment:
a. Tinker & Rasor, Model APS Holiday Detector
2. Field testing equipment:
a. Tinker & Rasor Model APS or M/1 Holiday Detector

2.2 MATERIALS

A. Coating Materials:
1. Products of a single Manufacturer.
2. Product substitutions during the Work will not be considered or permitted.

B. Purple, Pantone 2577 U, for recycled; blue or white for potable.

C. Tape Coating System:
1. Coating shall be applied as a four-layer system in accordance with AWWA C214 and consist of:
a. Liquid adhesive (primer), 2 mils to 3 mils.
b. Anti-corrosion tape (inner layer).
c. Mechanical-protective tape (third layer).
d. Mechanical-protective tape (outer layer).
e. Total thickness: 80 mils for pipe 16 inch diameter and larger and 50 mils for pipe 12 inch diameter and smaller:
1) Liquid adhesive layer: Black liquid consisting of a mixture of butyl rubber matrix suspended in a solvent capable of bonding to the steel surface and the anti-corrosion layer:
a) Thickness: Minimum 3 mils wet film thickness.
b) Handle, store, and apply in strict accordance with the Manufacturer's recommendations for hazardous materials.

2) Anti-corrosion layer: Consists of butyl rubber based pressure-sensitive adhesive laminated to a polyolefin (only) backing and compatible with the liquid adhesive layer; the Manufacturer shall certify the backing material is polyolefin only, containing not less than 1% nor more than 3.5%, by weight, of nonpolyolefinic material consisting of carbon black and antioxidants.
a) Thickness: Minimum 20 mils.
3) Mechanical-protective layers: Consists of a pressure-sensitive butyl adhesive laminated to a polyolefin (only) backing and be compatible with the anti-corrosion layer; the Manufacturer shall certify the backing material is polyolefin only, containing no less than 3% nor more than 7%, by weight, of nonpolyolefinic material consisting of pigments, antioxidants, and stabilizers.
a) Thickness: Minimum 30 mils per layer.

2. Coating of fittings and specials:
a. Tape coating system, general:
1) Fittings and specials which cannot be machine-coated as specified in this Section shall be coated in accordance with AWWA C209. Pre-fabricated tape shall be Type II and shall be completely compatible with the tape system used for straight line pipe. The system shall consist of three layers and the following:
a) Primer layer (2 mils to 3 mils).
b) Inner layer tape, corrosion protective tape (minimum 35 mils).
c) Outer layer tape, corrosion protective tape (minimum 35 mils).
2) Total thickness of tape coating: At least 70 mils not including primer.
b. Coating repair for fittings and specials shall be in accordance with the procedure as specified in this Section.
3. Exterior coatings shall be held back from the end of the pipe as shown on the Drawings to facilitate pipe joint installation.
4. Prepare the surface in accordance with SSPC SP 6/NACE No. 3 with a profile of 1 mil to 3 mils.

D. Viscoelastic Coating System:
1. Coating shall be applied as a two-layer system in accordance with AWWA C225 and consist of:
a. Viscoelastic inner layer: A non-curing, non-crystalline (fully amorphous), liquid-like non-crosslinkable polyolefin-based compound layer with a direct bond to the substrate, which can be reinforced by fabrics and be covered by a backing film. Referenced as the inner layer.
1) Total thickness: 59 mils, minimum.
b. Mechanical protective outer layer (outerwrap): A flexible cold-applied polymeric outer wrap for providing additional mechanical protection of the inner corrosion prevention layer. The purpose of the outer wrap is to provide additional circumferential compression, accelerate the bond, support self-healing, and provide additional mechanical protection for the coating system.
2. Coating of fittings and specials:
a. Molding compound:
1) To be molded around the surface of tees, flanges, valves, and other irregular shapes.
2) Cold-applied molding paste with cold flow and viscoelastic properties to form a monolithic layer.
a) Molding compound requires mechanical outerwrap.

2.3 FABRICATION
A. Weld Seam: Maximum weld seam height shall be 3/32 inches on longitudinal and spiral welds. Grind weld flush a full 18 inches along the length of the pipe, from both ends, prior to coating.

PART 3 EXECUTION

3.1 PREPARATION
A. Tape Coating System, General:
1. Remove visible oil, grease, dirt, and contamination from the pipe surface in accordance with SSPC SP 1. Kerosene shall not be used.
2. Remove metal slivers, sharp edges, burrs, weld splatter, gouges, delaminations, and other surface imperfections by filing or grinding prior to abrasive blasting in accordance with SSPC SP 2 and SSPC SP 3.
3. Protect pipe from humidity and wet weather conditions. Flash rust, imperfections, or contamination on cleaned pipe surfaces shall be removed by reblasting.
4. Complete priming and coating of the pipe surface on the same day as surface preparation.
5. Abrasive blast cleaning:
a. Abrasive blast surfaces to be coated with a commercial blast in accordance with SSPC SP 6/NACE No. 3 and obtain a 1 mil to 3 mil anchor profile measured in accordance with ASTM D 4417.
b. Abrasive mixture and gradation shall be as required to achieve the degree of cleanliness and coating adhesion required in accordance with SSPC AB 1 and SSPC AB 3.
c. Abrasive mixture shall be free of debris and foreign matter.
d. Regularly check blasted surfaces in accordance with SSPC VIS 1 to ensure the proper surface is attained.
e. Check the profile using replica tape and a spring micrometer at regular intervals in accordance with NACE SP0287.
f. Dry air blast or brush-off and vacuum blast surfaces showing flash rust stains prior to coating.

B. Viscoelastic Coating System, General:
1. Mechanically remove all weld spatters, laminations, slivers, high points, and other visual surface irregularities from the steel surface.
2. Remove metal slivers, sharp edges, burrs, weld splatter, gouges, delaminations, and other surface imperfections by filing or grinding prior to abrasive blasting in accordance with SSPC SP 2 and SSPC SP 3.

3. The surface of the pipe shall be clean, dry, and free from oil or grease in accordance with SSPC SP 1.
4. Properly prepare the steel pipe surface to a minimum cleanliness of SSPC-SP 3.
   a. An anchor profile by means of abrasive blasting is not required for the application of a viscoelastic system.
5. Epoxy-coated substrates shall be de-glossed and may be cleaned with light abrasive sweep blasting or by abrading with sand paper and degreasing by Isopropanol.

3.2 APPLICATION

A. Tape Coating System, General:
   1. Apply the coating system in a continuous operation as follows:
      a. Properly prepare the steel pipe surface by abrasive blast cleaning.
      b. Apply liquid adhesive (primer) to the blasted surface.
      c. Apply an anti-corrosion layer to the primed surface.
      d. Apply an initial mechanical-protective layer to the anti-corrosion layer.
      e. Apply a second mechanical-protective layer to the initial mechanical-protective layer.
   2. Liquid adhesive (primer):
      a. Apply in a uniform film to a wet film thickness of 2 mils to 3 mils.
      b. Apply primer at a minimum temperature of 50°F, continuously mix primer during application.
      c. Apply primer with a spray or rug type, or other suitable system as recommended by the Manufacturer.
      d. The primer surface shall be uniform and free from floods, runs, sags, drips, bare spots, and foreign matter such as sand, grease, oil, grit, rust particles, and dirt.
      e. Allow primer to dry in accordance with the Manufacturer's PDS prior to applying the anti-corrosion layer.
   3. Anti-corrosion layer:
      a. Apply the anti-corrosion layer directly on the liquid adhesive layer in a spiral fashion with a minimum overlap of 1 inch using mechanical constant-tension coating equipment.
      b. Maintain a tight, smooth, wrinkle-free coating layer throughout the application in accordance with the Manufacturer's recommendations.
      c. Apply the anti-corrosion layer at a roll temperature of 70°F.
      d. The end lap of the splice of a new roll shall overlap the end of the preceding roll a minimum of 6 inches measured circumferentially. The overlap shall be smooth and located to ensure the continuity of the anti-corrosion layer.
      e. Roll splicing shall occur prior to the new layer application and before the old roll break.
      f. A hard rubber roller wider than the width of the anti-corrosion layer shall be used to ensure maximum contact and conformability onto the surface in accordance with the Manufacturer's recommendations.
   4. Mechanical-protection:
      a. Layer 1:
         1) Apply mechanical-protection directly on the anti-corrosion layer in a spiral fashion using the same mechanical equipment used to apply the anti-corrosion layer.
         2) The overlap shall not coincide with the anti-corrosion layer overlap.
         3) The minimum overlap, end roll overlap, and roll temperature shall be the same values as specified in this Section.
      b. Layer 2: Apply the second mechanical-protection layer directly onto the first layer.
   5. Coating cutbacks:
      a. Coating cutbacks shall be determined by the type of pipe joint in accordance with the Manufacturer's recommendations and approved by the ENGINEER.
      b. Cutbacks shall be made with a cutting device guided from the end of the pipe to ensure a straight, uniform cutback.

B. Viscoelastic Coating System, General:
   1. Apply the coating system in a continuous operation:
      a. Properly prepare the steel surface by power tool cleaning to SSPC SP 3. Substrate cleanliness shall meet ISO 8502-3, grade 3.
      b. Apply the anti-corrosion inner layer.
      c. Apply molding compound (as needed).
      d. Apply mechanical-protective outer layer to the anti-corrosion inner layer and/or molding compound.
   2. Anti-corrosion inner layer:
      a. Apply with sticky side to substrate without tension, avoiding air entrapment, creases, and wrinkling. Remove release liner during application.
      b. Apply inner layer within a temperature range of 40°F to 113°F.
      c. Apply with an overlap of 1/2 inch, minimum.
      d. Overlap at least 2 inches onto adjacent pipe coating.
      e. Overlaps between the end of one roll and the start of a new roll shall be at least 4 inches.
      f. At terminations, (start/end points) one full straight wrapping shall be applied onto substrate followed by wraps from straight to spiral. End with one straight circumferential wrapping.
   3. Moldable compound:
      a. Properly prepare steel surface by power tool cleaning.
      b. Apply where needed such as valves, flanges, hardware.
      c. An ideal temperature of 85°F is required to obtain maximum cold-flowing properties of material.
      d. Apply wraps of 4 inch wide inner layer in the border areas outside the planned area where molding compound is to be applied.

e. Apply lumps or strips of molding compound all around shaped objects. The compound shall be firmly pressed avoiding air entrapments.
f. Apply smooth and tight on the substrate with a thickness no less than 3/4 inch.

4. Mechanical outerwrap:
a. Prior to application, clean the viscoelastic inner layer. Inner layer shall be dry and clean.
b. Apply outerwrap with tension.
c. The first two circumferential wraps shall be done without advancing the roll.
d. Begin the wrapping 1/5 inch inside the inner layer leaving 1/5 inch inner layer exposed.
e. Advance the roll by spiral wrapping with an overlap minimum of 50%. Subsequent rolls shall overlap the previous tape end by a minimum of 4 inches.
f. Begin application of consecutive roll at 3 o'clock or 9 o'clock position in the upward direction (tape end facing down).
g. Outer wrapping shall end 1/5 inch inside inner layer with two non-tensioned circumferential wraps.

3.3 REPAIRS

A. Tape Coating System:
1. Repair electrically detected holidays or visual flaws by removing all layers of coating from the damaged area. Coat the exposed area with liquid adhesive. Apply a patch of anti-corrosion tape directly over the liquid adhesive overlapping the existing tape by a minimum of 4 inches in all directions. Electrically inspect the repair area in accordance with NACE SP0188. If holiday free, apply two layers of mechanical-protective tape, each overlapping the previous tape by a minimum of 4 inches.
2. Repairs using tape in accordance with AWWA C209 or heat-applied patch material in accordance with AWWA C216 may be used as an alternate coating repair.

B. Viscoelastic System:
1. Coating shall be electrically inspected in accordance with NACE SP0188 prior to application of outerwrap. Repairs shall be made by cutting small pieces of inner wrap and applying them to clean, dry surface.
2. Repair visual flaws or mechanical damage by removing the outerwrap and applying cut patches of inner wrap to clean, dry surface.
a. Apply outerwrap to clean dry inner wrap surface.
b. Apply two circumferential wraps to repaired surface without tension.

3.4 PROTECTION

A. Welding Protection: Protect the pipe coating from weld splatter using an acceptable heat-resistant material.

B. Pipe Handling: The hoisting of pipe shall be completed using wide web belts or nylon slings. Metal clamps, chains, slings, and tongs are not permitted.

C. Field Procedures:
1. No metal tools or heavy objects shall come into contact with the finished tape coating.
2. Walking on the coated pipe shall be avoided to prevent damage to the coating.
3. The pipeline shall be backfilled in a way that prevents abrasion or other damage to the tape coating or viscoelastic coating.
4. Backfill shall be placed around the exterior of the coated pipe only after the final inspection has been made and the exterior coating has been approved.
5. Rodding with metal rods or other tools that could come into contact with and damage the tape coating are not permitted.

D. Joint Coating: The coating of field joints shall be determined by joint type and shall be in accordance with AWWA C209, AWWA C216, or AWWA C217.

3.5 QUALITY CONTROL

A. Testing:
1. Tape coating testing:
a. When visual inspection shows a portion of the tape-wrap system has sustained physical damage, the damaged areas shall be subjected to an electrical holiday test of 6,000 to 7,000 V.
b. Coating repair shall be made using tape and primer conforming to AWWA C209, Type II, compatible with the tape system used for straight line pipe.
c. Tape used for coating repair shall be the same color as the tape used for straight line pipe.
d. Following repair of the damaged area, if the holiday test indicates a holiday still exists, the inner wrap shall be exposed and the exposed area shall be wiped clean with xylol solvent and the area coated with tape primer. A patch of 35 mil thick cold-applied tape of sufficient size to cover the damaged area, plus a minimum lap of 2 inches in all directions, shall then be applied. The patched area shall again be tested for holidays. If none are detected, a second layer of 35 mil thick tape shall then be applied over the first patch. The second layer of tape shall overlap the first layer by a minimum of 2 inches in all directions.
e. When the area tests showing no holiday, a notation shall be applied to the area indicating the test is satisfactory.
2. Holiday testing:
a. Tape coating application plant testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage spark tester in accordance with NACE SP0188.
b. Tape coating field testing: Conduct holiday testing on the sufficiently cured pipe/fitting coating using a high-voltage spark or a low-voltage wet sponge tester in accordance with NACE SP0188.
c. Repair holidays or defects in the coating.

d. Viscoelastic field testing:
    1) Conduct holiday testing prior to application of outer wrap using a high-voltage spark tester in accordance with NACE SP0188.
    2) High-voltage holiday test shall be carried out at 15 kV. A clean metal-brush probe is recommended for testing.

B. Provide a final chronological testing report that includes:
1. Locations of testing (stationing).
2. Changes, modifications, and alterations from plans.
3. Comments relative to the Work.
4. Failures and defects.
5. Retesting information.

C. Prepare and apply tape coatings or viscoelastic coatings in accordance with referenced standards, the directions of the Coating Manufacturer, and the Contract Documents, whichever is more stringent.

D. Pipe coating materials shall be products of a single Manufacturer. Product substitutions during the Work will not be considered nor permitted.

E. Provide monitoring systems approved by the Manufacturer that constantly record pipe and coating conditions during the coating application. Recorded monitoring parameters include, but are not limited to, air temperature and humidity, pipe temperature, surface preparation, line speed, coating thickness, and holiday testing.

END OF SECTION

SECTION 09 97 14
COATING FOR VAULT HATCHES FOR WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for coating for vault hatches for water distribution system.

1.2 SUBMITTALS

A. Product Data: Base coat and top coat.
B. Color Samples.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Coating System:
   1. Carboline
   2. PPG Amercoat
   3. Tnemec

2.2 MATERIALS

A. Coating System:
   1. Determine compatibility between base coat and top coat.
   2. Base coat: Two-part, self-priming polyamide epoxy with maximum volatile solids content of 3.2 lbs/gallon.
   3. Top coat: High gloss alkyd enamel or polyurethane enamel with good abrasion resistance and weatherablity.
   4. Colors:
      a. Orange: Pantone 138C.
      b. Blue: Pantone 292C.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface shall be clean, dry and free of oil, grease and other contaminants.
B. Follow manufacturer's recommendations for further preparation, such as hand or power tool cleaning, or blasting.

3.2 APPLICATION

A. Coating:
   1. Base coat: Apply in one coat to 3.0 mils minimum DFT.
   2. Top coat: Apply in one coat to 3.0 mils minimum DFT.
   3. Provide sufficient cure time, in accordance with the Manufacturer's recommendations, between base coat and top coat.

B. Color:
   1. Color shall be achieved in top coat. Base coat may be of any color.
   2. Apply blue to entire exterior surface of hatch, except for trim stripe.
   3. Apply a 4 inch wide orange trim stripe to perimeter of hatch.

END OF SECTION

INTENTIONALLY BLANK

SECTION 10 14 23
INTERIOR PANEL SIGNS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for interior panel signs.

1.2 REFERENCES
- A. National Fire Protection Association (NFPA):
  1. 704 – Standard System for the Identification of the Hazards of Materials for Emergency Response

1.3 SUBMITTALS
- A. Product Data: Manufacturer's descriptive literature and specifications.
- B. Shop Drawings: Include sign locations, sizes, mounting heights, color, finish, message, and details of construction.
- C. Samples:
  1. Signs showing available colors: 3 inches by 3 inches.
  2. Submit a full-size sign of the type, style, and color specified including the method of attachment, with typical pictograms, characters, and braille indications.

1.4 QUALITY ASSURANCE
- A. In accordance with the applicable accessibility code for sign design, construction, location, and mounting height.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Plastic Signs:
  1. APCO Graphics, Inc.
  2. ASI Sign Systems, Inc.
  3. Best Sign Systems, Inc.
  4. Mohawk Sign Systems, Inc.
  5. Seton Identification Products
- B. Hazardous Material Signs:
  1. Brady Corporation
  2. Brimar Industries, SafetySign
  3. ComplianceSigns, LLC
  4. Emedco

2.2 MATERIALS
- A. Plastic Signs:
  1. Type: One-piece melamine plastic laminate with contrasting color core, nonstatic, fire retardant, self-extinguishing, matte finish.
  2. Thickness: 1/8 inch.
  3. Tactile characters/symbols raised 1/32 inch from the sign plate face.
  4. Braille: Text shall be accompanied by Grade 2 Braille.
  5. Character color: To be selected from Manufacturer's full color range.
  6. Background color: To be selected from the Manufacturer's full color range.
  7. Characters – restroom signs:
     a. Height: 5/8 inch.
     b. Style: Sans serif, style to be selected, upper case.
     c. Width to height ratio: Between 3 to 5 and 1 to 1.
     d. Stroke width to height ratio: Between 1 to 5 and 1 to 10.
  8. Characters – room signs:
     a. Height: 5/8 inch.
     b. Style: Sans serif, style to be selected, upper case.
     c. Width to height ratio: Between 3 to 5 and 1 to 1.
     d. Stroke width to height ratio: Between 1 to 5 and 1 to 10.
  9. Character placement: Centered.
  10. Corners: Square.
  11. Edges: Square.
  12. Border: 3/8 inch wide.
  13. Use: In accordance with the Contract Documents.
- B. Hazardous Material Signals (Type H):
  1. In accordance with NFPA 704.
  2. Material: Reflective sheeting applied to 0.040 inch thick aluminum.
  3. Background, letters, and numbers: Die cut vinyl with pressure-sensitive adhesive.
  4. Use: In accordance with the Contract Documents.

2.3 ACCESSORIES
- A. Adhesive: The type recommended by the Sign Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION
- A. Clean surfaces of loose and foreign matter.

3.2 INSTALLATION

A. Install in accordance with the Manufacturer's instructions and the approved Shop Drawings.
B. Locate signs on scheduled doors and at locations shown on the Drawings.
C. Schedule: Refer to the Sign Schedule in the Contract Documents for the sign types and quantities required for the Projects.

END OF SECTION

SECTION 10 14 60
EXTERIOR SIGNS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for exterior signs.
- B. Related Sections:
  1. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  2. A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  3. B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  4. D 4956 – Standard Specification for Retroreflective Sheeting for Traffic Control
- B. U.S. Department of Transportation, Federal Highway Administration (U.S. DOT/FHWA):
  1. Manual on Uniform Traffic Control Devices (MUTCD)

1.3 SUBMITTAL
- A. Shop Drawings: Include location, size, mounting height, and content of each sign.

1.4 QUALITY ASSURANCE
- A. Regulatory Requirements: In accordance with the applicable accessibility code for size, color, content, and height.
- B. In accordance with U.S. DOT/FHWA MUTCD.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Brady Corporation
- B. Emedco
- C. Seton Identification Products

2.2 MATERIALS
- A. Traffic and Parking Signs:
  1. Material: Reflective sheeting applied to 0.060 inch thick aluminum plate in accordance with ASTM B 209.
  2. Reflective sheeting: Type 1, tested in accordance with ASTM D 4956.
  3. Character color: To be selected from the Manufacturer's full color range.
  4. Background color: To be selected from the Manufacturer's full color range.
  5. Use: In accordance with the Contract Documents.
- B. Steel Tube: In accordance with ASTM A 500.

2.3 ACCESSORIES
- A. Posts: A 2 inch diameter galvanized steel tube with a steel plate cap welded on, and hot-dip galvanized after fabrication to ASTM A 123, G90 coating class.
- B. Concrete: Class B as specified in SECTION 03 30 00.
- C. Fasteners: Galvanized steel, the type best suited to the application, with vandal-resistant heads.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Install signs as shown on the approved Shop Drawings.
- B. Set plumb, level, and secure.
- C. Dome the top of the concrete footing to shed water.
- D. Brace signs until the concrete has set.
- E. Secure signs to the posts with two fasteners.
- F. Refer to the sign schedule in the Contract Documents for sign types and quantities required for the Work.

END OF SECTION

INTENTIONALLY BLANK

SECTION 10 21 00
TOILET PARTITIONS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for toilet partitions.

1.2 REFERENCES
- A. American National Standards Institute (ANSI):
  1. A117.1 – Accessible and Useable Buildings and Facilities
- B. Americans with Disabilities Act (ADA):
  1. Standards for Accessible Design
- C. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. A 743 – Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
  3. A 879 – Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
  4. B 86 – Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings

1.3 SUBMITTALS
- A. Product Data: The Manufacturer's product data and technical literature indicating the models to be used, data on hardware, accessories, and finishes, and conformance with the requirements of the specification.
- B. Shop Drawings:
  1. Floor plans indicating layout.
  2. Elevations fully describing the panels, anchorage, and accessory items.
- C. Samples: 2 inches by 2 inches showing the available colors.

1.4 QUALITY ASSURANCE
- A. Products and Installation: In accordance with ANSI A117.1.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Bradley Corporation, Mills Partitions
- B. Knickerbocker Partition Corporation
- C. Metpar Corporation
- D. Sanymetal, a Crane Plumbing Company

2.2 MATERIALS
- A. Steel Sheet: Commercial steel sheet for exposed applications; mil phosphatized and selected for smoothness.
  1. Electrolytically zinc coated: ASTM A 879.
  2. Hot-dip galvanized: ASTM A 653, either hot-dip galvanized or galvannealed..
- B. SST castings: ASTM A 743.
- C. Zamac: ASTM B 86, commercial zinc-alloy die castings.

2.3 COMPONENTS
- A. Partition Type: Floor anchored, overhead braced pilasters.
- B. Urinal Screen: Wall-hung, flat panel construction matching toilet partition panels.
- C. Panels: Two electrolytically zinc coated or hot-dip galvanized steel face sheets pressure bonded to a honeycomb core:
  1. Minimum thickness:
     a. Partitions and urinal screens: 20 gauge faces, 1 inch thick.
     b. Doors: 22 gauge faces, 1 inch thick.
     c. Pilasters: 20 gauge faces, 1 1/4 inches thick.
- D. Core: Sound deadening, moisture-resistant, resin impregnated cardboard honeycomb.
- E. Edges:
  1. Material: Die drawn steel, radiused, smooth continuous interlocking molding strip, mitered, welded, and finished at corners.
  2. Corners: Secured by welding or corrosion resistant clips.
- F. Headrail: Extruded aluminum channel with an anti-grip shape, designed to fit over the top of the pilasters, 2 inches by 1 inch.
- G. Pilaster Shoes: Minimum 3 inches high, Type 302 or Type 304 SST shoe, not less than 0.031 inch nominal thickness.
- H. Brackets (Fittings):
  1. Stirrup type: Ear or U-brackets; chrome-plated zamac.
- I. Hardware and Accessories: The Manufacturer’s standard design, heavy-duty operating hardware and accessories.
  1. Material: Chrome-plated zamac.
  2. Hinges: Paired, self-closing type that can be adjusted to hold the door open at any angle up to 90 degrees.
  3. Latch and keeper: Latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide lever handle latch in accordance with ADA requirements at compartments designated as accessible.
  4. Coat hook: Combination hook and rubber tipped-bumper, sized to prevent in-swinging door from hitting compartment mounted accessories.
  5. Door bumper: Rubber-tipped bumper at out-swinging doors.

6. Door pull: Unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

J. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of SST or chrome-plated steel or brass, with theft-resistant type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use SST, hot-dip galvanized steel, or other rust- resistant, protective coated steel.

K. Finish:
1. The Manufacturer's standard thermoset polyester enamel.
2. Color: As selected by the ENGINEER from the Manufacturer's full color range.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate the locations required for the installation of wood blocking or metal bracing for proper anchorage.

B. Verify that site conditions are ready to receive Work and are as shown on the approved Shop Drawings, including correct opening dimensions and spacing of plumbing fixtures.

3.2 INSTALLATION

A. Install partitions secure, plumb, and level in accordance with the Manufacturer's instructions.

B. Clearances:
1. Between wall and panels/pilasters: A maximum of 1 inch.
2. Between panels and pilasters: A maximum of 1/2 inch.
3. At vertical edges of doors: Uniform with a maximum of 3/16 inch.

C. Secure the pilaster to the floor with the appropriate fastener with an integral leveling screw concealed behind the base.

D. Attach panel brackets securely to the walls using theft proof fasteners and anchors as recommended by the Manufacturer.

E. Brace pilasters with overhead rail. Locate headrail joints at pilaster centerlines.

F. Hang doors from pilasters. Equip each door with two pivot hinges, a door latch, a door strike and keeper, and a coat hook and bumper. Install a door pull on out-swinging doors.

G. Installation Tolerances:
1. Maximum variation from true position: 1/4 inch.
2. Maximum variation from plumb: 1/8 inch.

3.3 REPAIRS

A. Touch up minor scratches and nicks in the paint finish with the same color and the same type of paint as the original finish. Repair in a manner that damage and refinishing cannot be detected.

3.4 PROTECTION

A. Clean, finish, and protect partitions until the Final Completion date.

3.5 ADJUSTING

A. Adjust and align hardware to operate smoothly and to a uniform clearance at the vertical edges of the doors.

END OF SECTION

SECTION 10 26 13
CORNER GUARDS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for corner guards.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  2. D 543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
  3. D 635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
  4. E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- B. National Fire Protection Association (NFPA):
  1. 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials
- C. Underwriters Laboratories (UL):
  1. 723 – Tests for Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS
- A. Product Data: Provide data and specifications on specified products.
- B. Shop Drawings: Include locations, extent, and standard details.
- C. Samples:
  1. Color chips, 2 inches by 2 inches, showing the Manufacturer's available colors.
  2. A 12 inch sample of each model specified, including end cap and mounting hardware.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 10 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of documented experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Performance Criteria:
  1. Fire performance: UL classified in accordance with NFPA 255, Class A or UL 723, Class I.
  2. Surface burning characteristics: Flame spread of 10 and smoke development of 350 to 450, tested in accordance with ASTM E 84.
  3. Chemical and stain resistance: Resistance to stain when tested in accordance with the applicable provisions of ASTM D 543.
  4. Self-extinguishing: CC1 classification, as tested in accordance with the procedures specified in ASTM D 635.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Store materials flat in the original, undamaged, factory packaging in a cool, dry place out of direct sunlight and exposure to the elements.

1.6 SITE CONDITIONS
- A. Maintain a temperature between 65°F and 75°F in the space to receive corner guards for 1 day before and 1 day after installation; subsequently maintain a 60°F minimum temperature.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Construction Specialties, Inc.
- B. InPro Corporation, IPC Door and Wall Protection Systems
- C. Tepromark International, Inc.

2.2 MATERIALS
- A. Surface-Mounted Hi-Impact Corner Guards:
  1. Type: Snap-on vinyl covers mounted on aluminum retainers.
  2. Cover: 0.078 inch thick extruded chemical and stain-resistant PVC, in accordance with ASTM D 543.
  3. Retainer: 0.080 inch thick, continuous, fabricated from 6063-T5 aluminum in accordance with ASTM B 221, with a mill finish.
  4. End caps: Molded ABS plastic in a color matching the cover.
  5. Size: 3 inches by 3-inches wings for a 90 degree corner.
  6. Impact absorber: Provide a concealed PVC impact absorber mounted onto the aluminum retainer.
  7. Color: To be selected from the Manufacturer's full color range.
- B. Fasteners:
  1. The type recommended by the Manufacturer for the substrates shown on the Drawings.
  2. Non-corrosive and compatible with aluminum retainers.

PART 3 EXECUTION

3.1 PREPARATION
- A. Clean substrate to remove dust, debris, and loose particles.
- B. Prepare substrate surfaces using the methods recommended by the Manufacturer.

3.2 INSTALLATION
- A. Install Work in accordance with the Manufacturer's recommendations.
- B. Use only approved mounting hardware.
- C. Set level and plumb with a secure attachment to anchoring surfaces.
- D. Install end caps with tight seams.

3.3 CLEANING

A. Clean exposed surfaces in accordance with the Manufacturer's instructions.

3.4 ADJUSTMENT

A. Adjust the end caps on the aluminum retainer to obtain a tight fit with the vinyl cover.

END OF SECTION

SECTION 10 28 13
TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for toilet accessories.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  2. A 269 – Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  3. A 480 – Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
  4. A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  5. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

1.3 SUBMITTALS
- A. Product Data: The Manufacturer's brochures showing sizes, details of function, finishes, and attachment methods.
- B. Closeout Submittal: Provide two keys for each type of lock to the OWNER.

1.4 QUALITY ASSURANCE
- A. In accordance with the applicable accessibility code for locating accessories.
- B. Provide products of the same Manufacturer for each type of accessory unit.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. AJW Washroom Accessories
- B. American Specialties, Inc.
- C. Bobrick Washroom Equipment, Inc.
- D. Bradley Corporation
- E. GAMCO

2.2 MATERIALS
- A. SST:
  1. Sheet: In accordance with ASTM A 480 or ASTM A 666; Type 304, rollable temper.
  2. Tubing: In accordance with ASTM A 269.
- B. Galvanized Steel: In accordance with ASTM A 1008.

2.3 ACCESSORIES
- A. Fasteners: SST where exposed, hot-dip galvanized where concealed; the type best suited to substrate conditions.

2.4 FABRICATION
- A. Use SST for exposed surfaces. Galvanized steel may be used in concealed locations.
- B. Form exposed surfaces from a single sheet of stock, free from joints, and flat, without distortion.
- C. Weld joints of fabricated components and grind smooth.
- D. Fabricate grab bars of tubing, free of visible joints, and return to the wall with end attachment flanges.
- E. Provide hangers, adapters, anchor plates, and accessories required for installation.
- F. Key locks alike and provide two keys.
- G. Shop assemble units and package complete with anchors and fittings.

2.5 FINISHES
- A. SST: No. 4 satin.
- B. Galvanizing: In accordance with ASTM A 123, to 1.25 oz/sf.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Install in accordance with the Manufacturer's instructions.
- B. Securely install to supporting construction and solid blocking using plates, screws, anchors, and other attachment devices provided by the Manufacturer of the same finish as the accessories.
- C. Set plumb, level, square, and rigid.

3.2 SCHEDULE

Item	Description	Manufacturer	Model No.
A	Mirror with Shelf	Bobrick	B-292
B	Handicap Tilting Mirror	Bobrick	B-294 1830
C	Recessed Towel Dispenser/Waste Receptacle	Bobrick	B-39617
D	Semi-Recessed Towel Dispenser/Waste Receptacle	Bobrick	B-3942
E	Paper Towel Dispenser	Bobrick	B-262
F	Toilet Tissue Dispenser	Bobrick	B-2740
G	Sanitary Napkin Dispenser	Bobrick	B-270

Item	Description	Manufacturer	Model No.
H	Grab Bars	Bobrick	B-6806 x 42
I	Grab Bars	Bobrick	B-6806 x 36
J	Grab Bars	Bobrick	B-6806 x 18
K	Mop and Broom Holder	Bobrick	B-223 x 36
L	Robe Hook	Bobrick	B-671
M	Extra Heavy Duty Shower Curtain Rod	Bobrick	B-6047

END OF SECTION

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for fire extinguishers.

1.2 REFERENCES
- A. ASTM International (ASTM):
  1. E 814 – Standard Test Method for Fire Tests of Penetration Firestop Systems
- B. National Fire Protection Association (NFPA):
  1. 10 – Standard for Portable Fire Extinguishers
- C. Underwriters Laboratories (UL):
  1. 299 – Dry Chemical Fire Extinguishers
  2. 711 – Rating and Fire Testing of Fire Extinguishers

1.3 SUBMITTALS
- A. Product Data: Include data on extinguishers and brackets, operational features, materials, finishes, and anchorage.
- B. Shop Drawings: Indicate bracket locations and mounting heights.
- C. Closeout Submittal – Maintenance Data: Include test, refill, or recharge schedules and re-certification requirements.

1.4 QUALITY ASSURANCE
- A. Provide fire extinguishers in accordance with UL 711 and NFPA 10.
- B. Cabinets in Fire Rated Partitions: Tested in accordance with ASTM E 814 with a fire resistance rating equivalent to adjacent construction.
- C. In accordance with the applicable accessibility code for locating extinguishers.

1.5 SITE CONDITIONS
- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Ansul Incorporated
- B. JL Industries
- C. Larsen's Mfg. Company
- D. Potter Roemer
- E. Type 3 Cabinet:
  1. JL Industries, Cosmopolitan 1036-V-17
- F. Brackets:
  1. JL Industries, Mark Bracket

2.2 COMPONENTS
- A. Extinguishers:
  1. Type 1: General building areas, multi-purpose dry chemical type containing a potassium bicarbonate based agent, in accordance with UL 299, cast steel tank, Class 60B:C, 10 lb nominal capacity. Bracket MB 846C.
  2. Type 2: Electrical equipment room areas, clean agent type containing Halotron 1, cast steel tank, Class 1A:10B:C, 10 lb nominal capacity. Bracket MB 812A.
  3. Type 3: General building areas, recessed cabinet:
     a. Cabinet: Cosmopolitan 1036-V-17 SST cabinet with a black powder-coated, cold-rolled steel tub.
     b. Extinguisher: Multi-purpose dry chemical type containing potassium bicarbonate based agent, in accordance with UL 299, cast steel tank, Class 3A:40B:C, 5 lb nominal capacity.
- B. Brackets: Formed-steel, sized to accommodate the extinguisher.

2.3 ACCESSORIES
- A. Mounting Hardware: The type best suited to the application.

2.4 FINISHES
- A. Brackets: The Manufacturer’s standard powder coating.
- B. Extinguishers: Baked enamel, red color.

PART 3 EXECUTION

3.1 INSTALLATION
- A. Install brackets in accordance with the Manufacturer's instructions.
- B. Anchor components firmly into position for long life under hard use.
- C. Set plumb, level, and rigid.
- D. Installation/mounting height:
  1. Extinguishers having a gross weight not exceeding 40 lbs shall be installed at 54 inches from the floor to the top of the fire extinguisher wall bracket.
  2. Extinguishers having a gross weight exceeding 40 lbs shall be installed so that the top of the extinguisher is no more than 42 inches above the floor.
- E. Place an extinguisher on each bracket.

END OF SECTION

INTENTIONALLY BLANK

SECTION 10 51 00
LOCKERS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for lockers.

1.2 REFERENCE
- A. American National Standards Institute (ANSI):
  1. A117.1 – Accessible and Usable Buildings and Facilities
- B. ASTM International (ASTM):
  1. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  2. A 1008 – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
  3. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

1.3 SUBMITTALS
- A. Product Data: For specified products and accessories, specifications, and finish data.
- B. Shop Drawings: Include locker types, sizes, and quantities, including necessary details for anchoring, trim installation, and relationship to adjacent surfaces.
  1. Numbering: Indicate the numbering sequence and include a review or notation section for the approving authority.
- C. Samples: Provide color charts showing the Manufacturer's available colors.
- D. Combination Locks: Provide combination listings and two master keys directly to the OWNER's Representative.

1.4 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A minimum of 10 years of documented experience in the Work of this Section.
- B. Installer Qualifications:
  1. A minimum of 5 years of experience in the Work of this Section.
  2. Approved by the Manufacturer.
- C. Regulatory Requirements: Metal lockers and benches in conformance with accessibility requirements, in accordance with ANSI A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. Do not deliver metal lockers until the building is enclosed and ready for locker installation. Protect from damage during delivery, handling, storage, and installation.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Art Metal Products
- B. Lyon Workspace Products, LLC, Standard Ventilated Lockers
- C. Penco Products, Inc., Standard Duty Lockers
- D. Republic Storage Systems, LLC., Standard Lockers

2.2 MATERIALS
- A. Cold-Rolled Steel Sheet: In accordance with ASTM A 1008, Commercial Steel (CS), Type B, suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: In accordance with ASTM A 653, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
- C. Extruded Aluminum: In accordance with ASTM B 221, alloy and temper recommended by the aluminum producer and the Manufacturer for type of use and finish indicated.

2.3 FABRICATION
- A. General: In accordance with the Contract Documents for style, size, and description.
- B. Door Frame:
  1. Vertical members: 16 gauge steel formed into one inch wide face channel shapes with a continuous vertical door strike, integral with the frame on both sides of the door opening.
  2. Cross members: 16 gauge steel channel shaped securely welded to vertical framing members to ensure a square and rigid assembly.
- C. Doors:
  1. Construction: 16 gauge steel, formed with a full channel shape on the lock side to fully conceal the lock bar, a channel formation on the hinge side, and a right angle formation across the top and the bottom.
     a. Single tier doors more than 60 inches in height and 18 inches in width: Provide a diagonal reinforcing angle welded to the inner surface.
     b. Doors for 3, 4, 5, and 6 openings high: 16 gauge steel formed with right angle flanges on all four sides.
  2. Ventilation: Integral louvers on the face of each door at the top and the bottom.
- D. Body:
  1. Construction: 24 gauge steel upright sheets.
  2. Top, bottoms, and shelves: Flanged on all four sides.
  3. Backs: Flanged on two sides.
  4. Uprights: Offset at the front and flanged at the rear to provide a double lapped rear corner.
- E. Locking:
  1. Locking device: Equip with a positive automatic pre-locking device whereby the locker may be locked while the door is open and then closed without unlocking and without damaging the locking mechanism.
  2. Locks: A built-in combination lock at each door.

F. Latching:
   1. Lock bar: Double channel steel construction.
   2. Latch: One-piece, pre-lubricated spring steel latch completely contained within the lock bar under tension to provide rattle-free operation.
   3. Latch points: Three latching points for lockers over 42 inches in height and two latching points for all tiered lockers 42 inches and under in height.
   4. Frame hooks: Heavy gauge steel, set close in and welded to the door frame. A continuous vertical door strike shall protect frame hooks from door slam damage.
   5. Hardware: Locker doors shall be equipped with a padlock hasp and a SST strike plate with an integral handle pull.

G. Hinges:
   1. Type: 2 inches high, five knuckle full loop tight pin style, securely welded to the frame and double riveted to the inside of the door flange.
   2. Quantity: No fewer than three hinges for each door more than 42 inches high.

H. Handles: A non-protruding 14 gauge SST lifting trigger and slide plate that actuates the lock bar when opening the door, with the exposed portion of the lifting trigger encased in a molded ABS thermoplastic cover and contained in a formed 20 gauge SST recessed pocket.

I. Interior Equipment:
   1. Shelf: One per locker.
   2. Wall hooks: Zinc-plated steel formed with ball points and attached with two bolts or rivets; one double-prong at the back, two single-prongs at the sides.

J. Number Plates: A polished aluminum number plate with black numerals no less than 1/2 inch high, attached with rivets to the lower surface within the recessed handle pocket.

K. Legs: In accordance with the Drawings.

L. Trim: Material to match the locker finish; installed using welded splice plates to create a secure splice and hairline butt joint and no exposed fasteners.

M. Finish:
   1. Surface preparation: Phosphatized in a seven-stage process to inhibit corrosion and increase the durability of the applied enamel.
   2. Type: The Manufacturer’s standard baked-on enamel.
   3. Color: As selected by the ENGINEER from the Manufacturer’s full color range.

N. Fasteners: Zinc-plated, low round head, slotless, fin neck machine screws with hex nuts, producing a strong mechanical connection.

2.4 ACCESSORIES

A. Locker Benches:
   1. Provide bench units with an overall assembly height of 17 1/2 inches.
   2. Bench tops: The Manufacturer's standard one-piece units, with rounded corners and edges.
      a. Size: Minimum 9 1/2 inches wide by 1 1/4 inches thick except provide minimum 20 inches wide tops where accessible benches are shown on the Drawings.
      b. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
   3. Fixed pedestals: The Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
      a. Tubular steel: 1 1/4 inches diameter steel tubing, with 0.1265 inch thick steel flanges welded at top and base; with baked-enamel finish; anchored with exposed fasteners.
         1) Color: Match metal lockers.

B. Recess Trim and Filler Panels: Fabricated from 0.0239 inch nominal thickness steel sheet. Finish to match lockers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install lockers in accordance with the Manufacturer's assembly instructions and the approved Shop Drawings.

B. Set level and plumb with flush surfaces and secure attachment to anchoring surfaces.

C. Fasteners:
   1. Space fasteners at 36 inches on center or less as recommended by the Manufacturer.
   2. Use fasteners appropriate to the load and the anchoring substratum.
   3. Use reinforcing plates wherever fasteners could distort metal.

D. Install trim accessories as shown on the Drawings, such as fillers and recessed trim using concealed fasteners.

E. Provide flush hairline joints at abutting trim parts and at adjoining surfaces.

3.2 ADJUSTMENT

A. Inspect the completed installation and adjust as necessary for proper door and locking mechanism operation.

B. Touch up minor scratches and abrasions with factory-supplied paint to match the original finish.

END OF SECTION

SECTION 13 47 13
COMMON WORK RESULTS FOR CATHODIC PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for common work results for cathodic protection.

B. Related Sections:

1. SECTION 13 47 17 – COMMISSIONING AND TESTING FOR CATHODIC PROTECTION SYSTEMS
2. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
3. SECTION 26 05 33 – RACEWAYS

1.2 REFERENCES

A. ASTM International (ASTM):

1. B 26 – Standard Specification for Aluminum-Alloy Sand Castings
2. D 3656 – Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

B. Federal Aviation Administration FAA):

1. AC 150/5320-6E – Airport Pavement Design and Evaluation

C. NACE International (NACE):

1. SP0104 – The Use of Coupons for Cathodic Protection Monitoring Applications
2. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
3. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

D. National Electrical Contractors Association (NECA):

1. 111 – Standard for Installing Nonmetallic Raceways

E. National Electrical Manufacturers Association (NEMA):

1. TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
2. TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
3. TC 7 – Smooth-Wall Coilable Electrical Polyethylene Conduit

F. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910, Subpart Q – Welding, Cutting, and Brazing, 252 (a)

G. SAE International (SAE):

1. AMS2770P – Heat Treatment of Wrought Aluminum Alloy Parts

H. Underwriters Laboratories, Inc. (UL):

1. 651 – Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

1.3 DEFINITIONS

A. Active Column of Deep Anode Groundbed: The portion of groundbed that discharges current; consists of anodes and coke breeze.

B. CP: The electrical method of reducing or eliminating corrosion by making previous anodic areas on the structure surface a cathode by creating a DC current flow to the structure by use of a CP system.

C. CP Criteria: In accordance with NACE SP0169.

D. CP Systems:

1. Galvanic anode system: Galvanic anode material, magnesium or zinc, which naturally corrodes or sacrifices itself and does not require an outside power source.
2. Impressed current system: Utilizes an outside power source, a rectifier that converts AC to DC current, and forces (impresses) current from a number of anodes (or groundbed) through the environment to the structure to be protected.

E. Coke Breeze: Low resistance, calcined petroleum, electrically conductive material.

F. Deep Anode Groundbed:

1. CP impressed current groundbed that is installed in a drilled hole at a prescribed depth from the structure being cathodically protected to achieve electrical remoteness.
2. Anodes and coke breeze are installed in the lower portion, active column; high resistant or sealing material is installed in the top section of the drilled hole, inactive column.

G. Electrically Continuous Pipeline: Linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable bond resistance for each joint as specified in this Section.

H. Electrical Isolation: The condition of being electrically isolated from other metallic structures and the environment in accordance with NACE SP0286.

I. Ferrous or Metallic Pipe: Pipe or structure made of steel or iron alloys and pipe or structure containing steel or iron as a principal structural material (e.g., steel, DI, and CI).

J. Functional and Performance Testing:

1. Testing that is necessary to demonstrate that the installed equipment and systems function as specified and operate in the manner intended.
2. Functional testing is a prerequisite to performance testing for equipment and systems that are specified to have a performance test.

K. ICCP: An impressed current CP installation location consisting of rectifier, groundbed, and anode terminal box.

L. Inactive Column of Deep Anode Groundbed: The portion of groundbed that does not discharge current; consists of the gravel fill, casing, and grout or concrete seal above the active column.

M. Lead, Lead Conductors, Joint Bond, and Cable: Insulated copper conductor, the same as conductor.

N. Local Authority: City, State, or County AHJ.

O. Other Utility-Owned: Buried pipe or cable not specifically owned or operated by the OWNER.

P. Raceways: Conduit for the casing of electrical or CP cables.
Q. Structure-to-Reference Electrode Potential or Structure-to-Reference Electrode Voltage: The difference in voltage, potential, between the subject metallic structure and the electrolyte in which it is buried or submerged, as measured to the standard specified reference electrode placed in contact with the electrolyte.

1.4 COORDINATION

A. Utilities:
1. Coordinate Work with other utilities within the Work area. Notify applicable utilities in writing prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.
2. Note existing utilities in the area and avoid damage to utilities.
3. Repair damage to utilities to the satisfaction of the ENGINEER and other utility owners at the CONTRACTOR's expense.

B. Existing Equipment to be Reused: Existing equipment (test stations, conductors, and other components) to be reused shall be cleaned and repaired. Verify the integrity of equipment intended to be reused.

1.5 SUBMITTALS

A. Include a complete itemized Bill of Material, including complete model number with options. Provide after the submittal table of contents and provide in the format specified in Supplement A.
B. Provide hard three-ring binders, fully indexed with permanent numbered tabbed section dividers and sequentially numbered pages. Section dividers with slide in paper tabs are not acceptable.
C. Provide review comments in written format and include original review comments. Provide documentation with responses in the Resubmittal or as a supplemental information document on Submittal dispositions of Final for Construction or Final for Construction as Corrected.
D. Label Submittal binders on front and ends/binds with a minimum of Submittal number, Specification Section, description, type of Submittal, and date.
E. Submittal drawings shall be 11 inches by 17 inches and not folded.
F. Include the complete Manufacturer's descriptive information and Shop Drawings for equipment, material, and devices, including certified outline drawings, arrangement drawings, dimensional layout drawings, schematic diagrams, interconnection and connection diagrams, literature, capacity, special features required, and equipment schedules, in accordance with the Contract Documents. The Manufacturer's catalog data for materials, include the Manufacturer's name and provide sufficient information to show that materials are in accordance with the Contract Documents.
G. Layout Drawings: Dimensioned plans and sections, showing arrangement, routing, depths, locations, and penetrations of raceways, conduits, splices, direct buried conductors, and equipment (e.g. test/bond stations, rectifiers, anodes, reference electrodes, water conduit exothermic weld locations, etc.).
H. Neatly cross out equipment, models, options, extraneous text, and other inapplicable items not being furnished that do not apply.
I. Provide additional information listed under individual Section items. Submittal information, including Shop Drawing Submittals, shall be included in the O&M manuals.
J. Drawings and computations prepared by or under the direct supervision of a Senior Corrosion Technologist or higher.
K. As-Built Drawings, including dimensioned locations, including depths, of anodes, reference electrodes, conductors, test stations, raceways, equipment, and devices. As-Builts shall legibly indicate number, size, tag numbers, and type of equipment, devices, and conductors.
L. Submit an evaluation report for each piece of equipment to be reused with details on the condition to the ENGINEER.
M. CONTRACTOR-Acquired GPS Points:
1. Provide GPS points accurate to within 10 cm of the true location of the asset. GPS points shall be taken for anodes, exothermic welds, coupons, reference electrodes, test stations, and conduit locations. Include time, date, technician, asset name, unique identifier (T_XXXX), and location reference as separate fields for each GPS point.
2. Provide GPS data in a CSV file.
3. Provide a report detailing the processing of each GPS point. Show either real time correction or post processing of GPS data, and detail specific calculations or conversions used.
4. Collect data in World Geodetic System 1984 Coordinate System (WGS 1984), unless otherwise approved by the ENGINEER.
5. Submit GPS data, including corrections and processing information, as part of the final As-Built Drawing Submittal.
6. Submit a comma separated values (CSV) file complete with the unique identifier (T_XXXX), X-coordinate, and Y-coordinate in the WGS 1984 datum.

N. Quality Control Submittals:
1. Senior Corrosion Technologist qualifications:
a. Provide name and contact information.
b. Currently certified by NACE.
c. A minimum of 10 years of documented experience in corrosion control.
d. Attend progress meetings as required.
2. Certificates of compliance: Components of test stations.
3. Progress checklists and results with a narrative.
4. Testing data conducted by a Senior Corrosion Technologist shall be provided 2 weeks prior to the Substantial Completion date and include:
a. The locations of testing, stationing.
b. Changes, modifications, and alterations from the Drawings.
c. Comments relative to the Work.

d. Failures and defects.
e. Retesting information.
5. Certificate of training completion from FreeWave.
6. Cover styles prototype test report.
7. Submit the intermittent test reports within 10 days of testing.
8. Documentation from an independent testing agency that the pit covers meet the specified load rating.

O. Warranty Documentation:
1. Sample warranty.
2. Warranty.

1.6 QUALITY ASSURANCE

A. Senior Corrosion Technologist:
1. Visit the site for testing and specification compliance verification bi-weekly at a minimum. The frequency of visits may vary as agreed with the ENGINEER.

B. The CP Subcontractor or the Electrical Subcontractor shall provide and install:
1. Conduit raceways.
2. Conductors: Anode, BRE, and coupon conductors shall be a standard component of the manufactured part.
3. Seal conduit raceways.

C. Equipment and materials, except as specified in this Section, shall be provided and installed by the CONTRACTOR or the CP Subcontractor.

D. The CP Subcontractor shall perform:
1. Test station terminations:
2. Testing as specified in SECTION 13 47 17.
3. Commissioning as specified in SECTION 13 47 17.
4. Conductor splices.

E. Materials fabrication and installation are subject to inspection and testing by the ENGINEER.

F. Hot Work Permit Program in accordance with OSHA 29 CFR, 1910, Subpart Q – Welding, Cutting, and Brazing, 252 (a) shall be established and in place prior to exothermic welding.

1.7 SITE CONDITIONS

A. Environmental Requirements: Store materials in covered and heated units to maintain minimum temperatures above the restricted temperature limits.

B. Materials and equipment shall be designed and constructed for continuous operation at rated current, at Project elevation, 104°F ambient, and 95% relative humidity.

C. Outdoor Equipment: Provide equipment and devices to be installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of -30°F to 104°F.

D. Inspection:
1. Drawings were developed from past As-Builts. Prior to submitting Bids or Proposals, verify dimensions and existing conditions including, but not limited to, structures, equipment, devices, conduits, etc.
2. Before submitting a Bid or a Proposal, the CONTRACTOR is required to determine conditions at the site and at existing structures to become familiar with existing conditions and electrical systems that will, in any way or manner, affect the Work required under the Contract. No subsequent increase in Contract Price will be allowed for additional Work required because of the CONTRACTOR's failure to fulfill this requirement.
3. Carry out any Work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such Work when approved by the ENGINEER.
4. During pre-construction activities, confer with the ENGINEER to verify, at each area of construction activity, the location of existing utilities, equipment, and structures and the requirements for adequately protecting them. Pay for required repairs if damage occurs during the Work.

1.8 WARRANTY

A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the CP system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. At Grade Test/Bond Station:
1. 6-inch CI valve box:
a. Provide 36 inches depth of working space inside of valve box
b. Valve box lid will be OWNER-furnished

B. Above Grade Test/Bond Station:
1. TESTOX, Series 900
2. TESTOX, Series 2000 may be utilized for test stations with more than seven terminals with ENGINEER approval.

C. DIA Flush Mount Test/Bond Stations:
1. Cavotec Dabico US, Inc., DAB-9-CPE-4-24D, Open Bottom, 4200391-D9 Door Water Cathodic Lid

D. BREs:
1. Borin, Stelth 2
2. Borin, Stelth 7 IR Free
3. GMC, STAPERM CU-1-UGPC

E. Sample Coupons:

1. M.C. Miller, carbon steel cylindrical coupon

F. Remote Monitoring Test/Bond Station:
1. FreeWave Technologies, Inc., Model, FGR2-CP

G. Exothermic Weld Equipment:
1. Cadweld
2. Erico Products, Inc.

H. Exothermic Weld Caps:
1. Royston Handy Cap IP for #10 AWG and smaller conductor connections
2. Royston Handy Cap XL IP for #8 AWG conductor and larger
3. Trenton Patch-Pad
4. Viscotaq Coating patch for Weld Connections

I. Over-Voltage Protection:
1. Dairyland PCR

J. Splices:
1. Burndy:
   a. Insulink, Type SN insulated compression butt splices
   b. Hylink, Type YSV-L uninsulated compression butt splices
2. 3M Conductor Splice Kit:
   a. 3M Scotchfil electrical insulation putty
   b. 3M 130C rubber tape
   c. 3M super 88 vinyl electrical tape
   d. 3M Scotchkote electrical coating

K. Conductor Marking Sleeve
1. Brady PermaSleeve Conductor Marking Sleeve

L. Warning Tape:
1. Brady, Catalog #91601

M. Shunts:
1. Cott, 0.01 ohm, 8 A, yellow

2.2 MATERIALS

A. At Grade Test/Bond Station:
1. General
   a. Include test conductors, terminal box with terminal board and lid, exothermic weld conductor to structure attachment, and applicable structure coating repair.
   b. The 18-inch ABS plastic box with 6-inch I.D. and standard with a 1 1/2-inch CI flange for heavy duty installation at grade level.
   c. Provide adjustable to grade type.
2. Test station lid:
   a. Heavy CI.
   b. Painted blue.
   c. One-piece non-locking.
   d. Terminal blocks are secured in place beneath the lid.
   e. Imprinted into cover: DW CP.
3. Terminal blocks and box:
   a. Conductor: Provide five terminal minimum and connections required.
   b. Solid brass terminals.
   c. Boxes flared and squared to prevent pull-out, turning or settling.
   d. Provide terminal jumpers as required.
   e. SST ID tag with T_#### on terminal block. T_#### shall be a unique identification for each test station.
   f. Provide T_#### identification numbers shown on the Drawings or as approved by the ENGINEER.

B. Above Grade Test/Bond Station:
1. Include station, lid, and terminal box with terminal board. Post and installation as shown on the Drawings.
2. Cast aluminum waterproof threaded test station top and threaded cover.
3. Terminals: Five, minimum.
4. Option for pad lockable type.
5. Imprinted into cover: DW CP and T _####.
   a. T_#### shall be a unique identification for each test station.
   b. Provide T_#### identification numbers shown on the Drawings or as approved by the ENGINEER.
   c. Text centered on test station. Characters shall be 1/2 inch minimum. Characters depth shall be 1/8 inch minimum, unless otherwise approved by the ENGINEER.

C. Conductors:
1. General: Conductors shall be installed as specified in SECTION 26 05 19, the Contract Documents, and the Manufacturer's recommendations.
2. Description:
   a. For test stations: Single-conductor #12 AWG stranded conductor with Type RHH/RHW/USE insulation.
   b. For bond stations: #10 AWG seven-strand conductor with RHH/RHW insulation, manufactured with blue insulation.

c. For impressed current bond stations: #8 AWG seven-strand conductor with RHH/RHW insulation, manufactured with blue insulation

3. Conductor insulation color coding:
   a. Water pipelines: Blue.
   b. Reuse water pipelines: Purple.
   c. Oil/gas pipelines: White.
   d. Coupon leads or recycled water pipelines: Green.
      1) If installation requires both, consult the ENGINEER for conductor colors.
   e. Casings: Orange.
   f. Anode leads: Black.
   g. Permanent reference cell leads: Yellow.
   h. Power/electric lines: Red.
   i. Communications lines: Gray.
4. Splices:
   a. Components and materials:
      1) Compression butt splices.
      2) Electrical insulation putty.
      3) Rubber tape.
      4) Super 88 vinyl electrical tape.
      5) Electrical coating.
5. Conductor marking sleeve.

D. DIA Flush Mount Test/Bond Stations:
1. Provide at DIA in high loading areas including, but not limited to, concourses, aprons, and taxiways.
2. Include test conductors, pit cover, and fiberglass pit.
3. Test conductors: Conform to the description herein.
4. Pit cover:
   a. Primary metal cast aluminum in accordance with ASTM B 26 with T-6 heat treatment in accordance with SAE AMS2770P, no exceptions.
   b. Diameter: 9 inches.
   c. Maximum 15 lb lift.
5. Emboss with: WATER CATHODIC and T_####. T_#### shall be unique. Unique numbers will be provided by the ENGINEER.
   a. In accordance with FAA AC 150/5320-6E.
   b. Free of visible shrink porosity cavity areas, fillers, weldments, and paint to hide them (area colored/point-welded for information is allowed).
   c. Weight bearing mating flange surfaces of pit cover will be flat to within 0.050 inch total indicator reading.
6. Fiberglass pit:
   a. Opening diameter to match lid, 9 inches diameter.
   b. Wall thickness: 1/4 inch.
   c. Integral concrete anchors.
   d. Open bottom.
   e. Integral top flange will require no extraneous corrosive material, weldments, or strongbacks to support cover.
7. Testing of pit cover for DIA flush mount test/bond stations: Cover loading over footprint shall result in minimum 740 psi rating with a maximum 0.100 inch full load deflection at the center indicator and a deflection rebound within 0.010 inch after load release.

E. BREs:
1. For buried locations:
   a. CSE.
   b. Minimum design life of 20 years.
   c. Moisture content change in soil has no effect on electrode performance.
   d. Stability: 5 mV under a 3.0 micro amp load.
2. Lead conductor:
   a. #14 AWG, stranded copper type RHH/RHW or HMWPE with yellow insulation.
   b. Length: Minimum of 30 feet, sufficient to extend from electrode location to termination location without a splice.
   c. Attach to the electrode with the Manufacturer's standard connection.
3. Package in a low-resistivity backfill formulated to retain moisture and maintain stability.
4. Provide IR free potential for impressed current systems by use of coupon electrode in accordance with NACE SP0104.
5. Initial accuracy to be ±15 mV referenced to a calibrated portable reference electrode.

F. Sample Coupons:
1. Provide coupon of metallurgical similarity to the pipe of interest. Coupons shall be cylindrical and have two redundant test leads. Product selection shall be in accordance with NACE SP0104.
2. Provide #10 AWG to #12 AWG green RHH/RHW or THHN conductor for coupons. Conductors shall have no splices without ENGINEER approval and be of sufficient length to terminate in test station.

G. Exothermic Weld Equipment:

1. Include welder mold, exothermic weld charges, metal disk, conductor sleeve, ignition source, and exothermic weld caps.
2. Welder molds:
   a. Graphite molds sized for each type and size of charge and pipe size.
   b. Type: As recommended by exothermic welds Manufacture for appropriate conductor size.
3. Exothermic weld charge:
   a. Mixture of copper oxide and aluminum material ignited by magnesium starting powder with spark.
   b. Materials: Designed for the connection of copper to steel or DI and CI surfaces.
4. Steel disk: A 0.005 inch to 0.007 inch steel disk designed to fit at the bottom of the welder mold barrel.
5. Ignition source: A flint gun igniter capable of igniting the weld charge in a safe manner, electronic method is also acceptable.
6. Conductor sleeves:
   a. Copper adapter sleeves to build up conductors to fit welder molds.
   b. Size and type: As recommended by the Manufacturer.
7. Exothermic weld caps:
   a. A pre-fabricated weld cap filled with elastomeric mastic coating and a layer of tapecoat gray protective adhesive with integrated primer.
   b. Minimum 4 inches by 4 inches.

H. Over-Voltage Protection – Polarization Cell:
1. Solid-state DC isolation/AC grounding device suitable for induced AC voltage mitigation.
2. Provide a NEMA 4X enclosure and include:
   a. SST name plate.
   b. Connectors: Compact or four-hole NEMA terminals.
   c. Pedestal for mounting in enclosure.
   d. Pedestal mounting enclosure.
      1) Size: 36 inches high by 14 inches wide by 9 inches deep.
      2) Color: Light green.
      3) Nominal fiberglass thickness: 3/16 inch.
      4) Exterior: UV stabilized gelcoat 14 mil.
      5) Fire retardant.
      6) SST hardware.
   e. HMWPE, stranded copper conductor.
   f. Bare, stranded copper conductor for grounding: 50 feet.
   g. Hardware for connections.

I. Conductor Raceways:
1. General: Raceways shall be installed as specified in SECTION 26 05 33 and the Manufacturer's recommendations.
2. PVC Schedule 40 conduit:
   a. In accordance with NEMA TC 2 and UL 651.
   b. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90°C insulated conductors.
3. PVC conduit fittings:
   a. In accordance with NEMA TC 3.
   b. Type: PVC, slip-on.
4. HDPE conduit:
   a. In accordance with NEMA TC 7.

J. At Grade Test/Bond Station Tags:
1. Material: SST.
2. Shape: 1 1/2 inches diameter round, 1/16 inch thick (0.0625 inch).
3. Test/bond station designation: Laser engraved.
4. Affix tags with SST braided conductor.
5. With wire crimp attachment.
6. Text centered on tag:
   a. At least 0.188 inch characters.
   b. T_####.
7. Affix to at grade test/bond stations with SST components by ENGINEER-approved methods and location.

K. Conductor Marking Sleeve:
1. Heat shrinkable conductor marking sleeve:
   a. Matte finish.
   b. 1 1/4 inches length.
   c. Text on tag:
      1) Wire ID: WIRE_####.
         a) See conduit and conductor schedule.

L. Warning Tape:
1. Material: Detectable polyester. Color: Red.
2. Width: Minimum 2 inches.

3. Designation: Warning on tape: Caution: Buried CP Electrical Lines.

PART 3 EXECUTION

3.1 GENERAL

A. Use above grade test/bond stations where possible.
B. Locate above grade test/bond stations behind the sidewalk or off the roadway at a safe distance out of the traffic pattern.
C. If an above grade test station is not feasible in a particular location, then an at grade test/bond station may be used with prior approval of the ENGINEER.
D. Locate the at grade test/bond station at the edge of the curb and out of the pavement if possible. If no curb and gutter exist, locate the test/bond station at a safe distance out of the existing traffic pattern.
E. Use continuous test/bond station lead conductor without cuts, tears, or splices in the insulation. Splices will be allowed with the written approval of the ENGINEER.
F. Attach test lead conductors to the pipe by exothermic welding.
G. Attach test lead conductors to the pipe prior to backfilling.
H. Use color-coded test conductors as indicated herein.
I. At other utility-owned line crossings test stations, notify the owner of the pipeline and obtain permission before test leads are connected to their pipeline; the OWNER shall have a representative present.
J. Test the test/bond station prior to and after backfill in accordance with NACE SP0169. Coordinate testing with the ENGINEER.
K. Repair coating or lining damage due to CP installation.
L. Exercise extreme caution during the installation procedure to prevent damage to leads.
M. Replace damaged leads at the CONTRACTOR's expense.

3.2 INSTALLATION

A. Install Test/Bond Stations:
   1. On continuous pipelines, not exceeding 1,000 feet apart.
   2. At major underground pipeline crossings.
   3. At cased crossings.
   4. At underground isolation flanges and couplings.
   5. At other locations as shown on the Drawings.
B. Test/Bond Station Locations:
   1. Locations shown on the Drawings are approximate.
   2. Determine exact locations by field conditions, non-interference with other utilities, or mechanical and structural features.
C. Above Grade Test/Bond Stations:
   1. Coil sufficient slack in the leads around the temporary post at the test/bond station location during the backfilling operation.
   2. Remove the temporary conductor post and excavate a 12 inch by 12 inch by 12 inch hole around leads.
   3. Feed leads up through the bottom of the test/bond station leaving a minimum of 2 feet of slack at the top of the post.
   4. Set the post upright in the hole and backfill and tamp soil firmly around the post to a depth of 3 inches below the finished grade.
   5. Coil conductors, place in the top of the post, and attach Testox Test Station by threading clockwise to the top of the post.
   6. Ensure the test post is plumb with the finished grade, and installed level vertically.
   7. Provide a 1 inch diameter breather hole and cover with an ASTM D 3656, Class 1 or 2 bug screen.
D. At Grade Test/Bond Stations:
   1. Provide sufficient slack coiled beneath the test/bond station to allow for soil settlement and to prevent damage to leads during backfill.
   2. Leave additional slack, 18 inches minimum, to allow for the withdrawal of conductor above the top of the box for test purposes.
E. DIA at Grade Test/Bond Stations:
   1. Drill a 1 inch hole in the side of the fiberglass pit, 10 inches below the top of the pit and the thread hole, to accommodate 1-inch threaded grommet.
   2. Thread 1-inch PVC grommet into the pit opening until the two threads are showing inside the pit.
   3. Insert test/bond leads and BRE and anode leads into the pit through the PVC grommet.
   4. Provide sufficient slack, 24 inches minimum, coiled in the pit to allow for the withdrawal of conductor above the top of the pit for test purposes.
   5. Locate and install the pit in an area where no test leads, BRE leads, or anode leads are directly below the pit, and at the proper elevation ensuring the pit lid is at the finished grade.
   6. Backfill around the pit with fill material to the specified compaction up to bottom of concrete apron.
   7. Place apron concrete around the pit and finish.
   8. Clean excess concrete or debris off the pit lid and in the pit flange area to ensure the ease of lid operation and proper aircraft wheel load distribution.
F. BREs:
   1. Prior to installation, soak BREs in a 5 gallon container of potable water for 30 seconds.

2. Calibrate the BRE in the presence of the ENGINEER by measuring the potential difference between the BRE and an independent and portable calibrated reference electrode placed in the water adjacent to the BRE. The potential difference between the two electrodes of the same generic type shall not exceed 15 mV when the sensing windows of the two electrodes being compared are not more than 1/16 inch apart but not touching. BREs not within these potential differences shall be removed and replaced at the CONTRACTOR's expense. Prior to completely backfilling over reference electrodes, re-verify the accuracy of the BRE. The testing provision also applies to replacement BREs.
3. Install BREs horizontally 12 inches to 24 inches from the pipe, below the springline with the conductor attachment side away from pipe.
4. Compact native soil by hand around the electrode.
5. Extend the electrode lead conductor up and into the test/bond station in accordance with the Contract Documents.

G. Sample Coupons:
1. Install sample coupon 4 inches to 12 inches from the pipe of interest. Seat coupon level with pipe invert and no higher than 1/3 of a pipe diameter.
2. Coupon shall be installed within 12 inches of the BRE. Coupon shall be a minimum of 24 inches from nearest anode.
3. The soil surrounding the coupon shall be compacted enough that no voids form around the coupon.
4. Installation of coupon shall be in accordance with NACE SP0104.

H. Test/Bond Station Lead Conductor Attachment:
1. Attach lead conductor to the pipe by exothermic welding.
2. The pipe to which conductors are to be attached shall be clean and dry.
3. Use a grinding wheel to remove coating, mill scale, oxide, grease, and dirt from an area approximately 3 inches square.
4. Grind the surface to bright metal.
5. Obtain approval from the ENGINEER for the chemicals proposed for use in surface preparation.
6. Remove approximately 1 inch of insulation from the end of the conductors to be exothermic welded to the structure, exposing clean, and oxide free copper for welding.
7. Using the Exothermic Weld Manufacturer's recommended mold, place the conductor between the graphite mold and the prepared metal surface.
8. Use the sleeve crimped over the conductor.
9. Place the metal disk in the bottom of the mold.
10. Pour the exothermic weld charge into the mold.
11. Squeeze the bottom of the cartridge to spread the ignition powder over the charge.
12. Close the mold cover and ignite the starting powder with a flint gun.
13. After the exothermic reaction, remove the exothermic weld mold and gently strike the weld with a hammer to remove weld slag.
14. Pull on the conductor to ensure a secure connection.
15. If the weld is not secure or the conductor breaks, repeat the procedure.
16. If the weld is secure, cover it with a plastic weld cap in accordance with the Contract Documents.

I. GPS Locations:
1. Notify the ENGINEER in writing a minimum of 1 day prior to backfilling exothermic weld connections, anodes, BREs, and test/bond stations.
2. The CONTRACTOR will obtain GPS locations on exothermic weld connections and corresponding anodes, BREs, and test/bond stations.

J. Post Installation Backfilling of the Test/Bond Station – Lead Conductors:
1. Protect the test/bond station lead conductors to prevent damage to conductor or insulation during backfilling.
2. After completion of backfilling of test lead conductors to pipe, verify the connection by recording a pipe-to-soil potential.
3. Replace test lead conductors that are damaged or have a high resistance connection.

K. Conductors:
1. Conductors shall be installed as specified in SECTION 26 05 19, and in accordance with the Contract Documents and the Manufacturer's recommendations.
2. Conductor marking sleeves:
   a. Install marking sleeve within 6 inches of termination. Marking sleeve shall be clearly visible in test station.
      1) Label conductors (WIRE_###) with conductor marking sleeve as shown on the conduit and conductor schedule on the Drawings. Connect to terminals using appropriate conductor connector. Label terminal board in test station.
3. Conductor splices:
   a. Apply splices in five successive steps:
      1) Crimp compression butt splices by the Manufacturer's recommended procedure and equipment.
      2) Wrap crimp in electrical insulation putty.
      3) Apply rubber tape to outside of insulation putty.
      4) Wrap splice with vinyl electrical tape.
      5) Apply two coats of electrical coating product to entirety of splice, ensuring voids are filled in.
   b. 600 V or less splices and terminations connectors shall be insulated with a minimum of 6 mm of electrical insulating putty. Cover entire connection with 6 mm of electrical insulating putty. Overwrap insulating putty

with a rubber tape stretched just before its breaking point to fill in voids and crevices, half-lapped in successive layers. Apply vinyl tape with the same tension as it has when it comes from the roll. Provide at least four uniform layers of vinyl tape, half-lapped in two directions. Coat splice completely twice with electrical coating and let cure ion accordance with the Manufacturer's recommendations prior to burial or submersion.

L. Raceways:
1. Installed Work shall be in accordance with NECA 111.
2. Crushed or deformed raceways not permitted.
3. Maintain raceway entirely free of obstructions and moisture. Protect products from effects of moisture and physical damage during construction.
4. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
5. Seal raceways with Polywater AFT aerosol foam after conductors are installed.
6. Install concealed raceways with a minimum of bends in the shortest practical distance. Bends shall not exceed 270 degrees between pulling points, unless otherwise approved by the ENGINEER.
7. Provide factory-made bends for bends 30 degrees and larger. Use the Manufacturer's recommended method for forming smaller bends.
8. Maintain a minimum of 2 foot cover above conduit, unless otherwise approved by the ENGINEER.
9. Make routing changes as necessary to avoid obstructions or conflicts.
10. Installation with other piping systems:
    a. Crossings: Maintain minimum 12 inches vertical separation.
    b. Parallel runs: Maintain minimum 12 inches separation.
    c. Installation over valves or couplings not permitted.
11. Underground conduits shall be sloped to drain from test/bond stations to the underground equipment and connections.
12. Support conduit so as to prevent bending or displacement during backfilling. Do not backfill until inspected by the ENGINEER
13. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.
14. Warning tape: Install approximately 12 inches above underground raceways. Align parallel to, and within 12-inches of centerline or runs.

3.3 QUALITY CONTROL

A. Testing of Remote Monitoring Test/Bond Stations:
1. Full factory test including:
    a. Firmware download test.
    b. Functional bench test.
    c. Auto program test.
    d. Burn in test with full temperature cycle from -40°F to 158°F.
    e. Radio link test.
    f. Data integrity test.
    g. Sample batch testing is not acceptable.

B. Intermittent and Final Testing:
1. Test the CP system periodically during construction and after construction is complete to ensure proper functionality in accordance with NACE SP0169.
2. Notify the ENGINEER in writing a minimum of 2 days prior to testing.
3. The ENGINEER will observe or assist with testing.
4. Locate, identify, and correct construction defects, malfunctions, or incomplete Work.
5. Retest the system in the presence of and to the satisfaction of the ENGINEER.
6. Defects found by the OWNER during the warranty period shall be corrected at the CONTRACTOR's sole expense, including additional engineering, retesting, and inspection time.
7. Final testing and commissioning as specified in SECTION 13 47 17.

3.4 SUPPLEMENTS

A. Supplement A – Bill of Materials Example

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A – BILL OF MATERIALS EXAMPLE
WTP Generators 1 & 2
Contract #: --
Submittal #: --

Equipment/ Specification	Item	Qty.	Description	Manufacturer	Complete Manufacturer Part No. (with all options)	DW Device Abbrev/Tag
26 05 00			Control & Protection Equipment			
-2.1	1	1	GPS	Basler	BE1-GPS100-E3N1H1N	GPS2
-2.2	2	4	OPS	Basler	BE1-951-E3N1H5N	OPSL, OPSR, OPSG, OPS2
-2.4	3	5	Sync-Check relay (25SC)	Basler	BE1-25 M1FA6PA5R6F	25SCL, 25SCR, 25SCG, 25SCL2, 25SCG2
-2.6	4	1	Line voltage over/under relay (27/59A)	Basler	BE1-700 N3N2X7N	27/59L2
-2.7	5	1	Low Power Relay (37G)	Basler	BE3-37-3E1A2	37GA
-2.8	6	3	Power Transducer	Yokogawa	2469-32-330-AHD-1	VTDL2, VTDG2, VTDB
-2.9	7		Control Switches	Electroswitch		GCP1, GCP2
-2.9	8		Control Switches, LOR	Electroswitch	7805D	86L1, 86R1, 86G1, 86L2, 86G2
-2.10	9		Test Blocks	GE		GCP1, GCP2
-2.10	10		Test Plugs	GE		GCP1, GCP2
	11	2	Generator Control System	Woodward	EasyGen 2000	GCP1, GCP2
	12	2	Genset control for multiple unit operation (EasyGen 3200), P1 option and 5A CT inputs	Woodward	8440-2050	GCP1, GCP2
	13	2	DPG Programming Kit	Woodward	8447-1003	G2
	14	1	Digital speed controller	Woodward	DPG-2401-002	G2
-2.9	15	5	Lock out relay, four-decks (16 sets of contacts), lights	Electroswitch	78PB04D	86L1, 86R1, 86G1, 86L2, 86G2
-2.9	16	2	Switch, breaker control	Electroswitch	2438D	GCP1, GCP2

INTENTIONALLY BLANK

SECTION 13 47 14
IMPRESSED CURRENT CATHODIC PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for impressed current cathodic protection.

B. Related Sections:

1. SECTION 07 92 00 – JOINT SEALANTS
2. SECTION 13 47 13 – COMMON WORK RESULTS FOR CATHODIC PROTECTION
3. SECTION 13 47 17 – COMMISSIONING AND TESTING OF CATHODIC PROTECTION SYSTEMS
4. SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL
5. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
6. SECTION 26 05 33 – RACEWAYS
7. SECTION 27 00 00 – COMMUNICATIONS SYSTEMS
8. SECTION 40 50 00 – INSTRUMENTATION AND CONTROL SYSTEMS

1.2 REFERENCES

A. ASTM International (ASTM):

1. A 518 – Standard Specification for Corrosion-Resistant High-Silicon Iron Castings
2. D 1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
3. D 1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
4. F 480 – Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

B. NACE International (NACE):

1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
2. SP0572 – Design, Installation, Operation, and Maintenance of Impressed Current Deep Anode Beds

1.3 DEFINITIONS

A. As specified in SECTION 13 47 13.

1.4 SUBMITTALS

A. As specified in SECTION 13 47 13.

B. Quality Control:

1. Certificates of compliance:
   a. Impressed current anode: Independent laboratory analysis certifying that the anode supplied is in accordance with the Contract Documents.
   b. ICCP and corrosion control monitoring systems including, but not limited to, joint bonding, test stations, and insulators are demonstrated fully operational.
   c. Copies of field-collected data, including:
      1) As-Builts of installation and construction of ICCP and accurate location and type of anodes, conductors, conduits, AC service drop, rectifier, pipe connections, and junction boxes.
      2) Deep anode groundbed As-Built information including, but not limited to:
         a) Drillers log.
         b) Initial well resistance log from the casing to the bottom of the drilled hole at 5 foot intervals.
         c) Final anode placement, coke breeze, casing, and seal depths.
         d) An anode resistance data summary before and after backfilling with coke breeze.
         e) Location adjustments for review.
   d. Testing data: As specified in SECTION 13 47 17.
2. Provide the ENGINEER with a proposed test procedure and equipment list for review and approval prior to beginning drilling operations.

C. Submittals from other Sections and equipment shall not be combined.

D. Include a complete itemized Bill of Material, including complete model number with options. The Bill of Material shall be provided after the Submittal table of contents and shall be in the format as specified in SECTION 26 05 00, Supplement A.

E. Provide in quality, hard, three-ring binders, fully indexed with permanent numbered tabbed section dividers and sequentially numbered pages. Section dividers with slide in paper tabs will not be accepted.

F. Report to the ENGINEER Submittal review comments in written format and include original review comment. Provide documentation with responses in the resubmittal or as a supplemental information document on Submittal dispositions of final for construction or final for construction as corrected.

G. Label Submittals binders on front and ends/binds with a minimum of submittal number, Specification Section, description, type of submittal, and date.

H. Submittal drawings shall be 11 inches by 17 inches and not folded.

I. Include the complete Manufacturer's descriptive information and Shop Drawings for equipment, material, and devices, including certified outline drawings, arrangement drawings, dimensional layout drawings, elementary, schematic, diagrams, interconnection and connection diagrams, literature, capacity, special features required, schematic, elementary, control diagrams, equipment schedules, and characteristic curves for protective devices in accordance with provisions elsewhere in the Contract Documents.

J. Equipment, models, options, extraneous text, etc. not being furnished and that do not apply shall be neatly crossed out.

K. No more than two Manufacturers of specified materials such as raceway systems, conductors, cables, and etc. shall be provided and included in a Submittal.

L. An Equipment Manufacturer certified letter stating that the equipment provided meets the site environmental conditions.
Provide additional information listed under individual Section items. Submittal information, including Shop Drawing Submittals, shall be included in the O&M manuals.

M. As-Built Drawings, including dimensioned locations of raceways, groundbeds, layout, equipment, and devices. As-Builts shall legibly indicate number, size, tag numbers, and type of equipment, devices, conductors, and cables. Where clarity of raceway locations cannot be established on floor plans, elevations shall be provided. As-Built conduit/conductor schedules, including lengths, nameplates with exact text, schematic connection diagrams, control schematics, wiring diagrams, P&IDs, connection diagrams, etc.

N. Provide a photo album of the complete construction of the Work.

O. Warranty Documentation:
1. Sample warranty.
2. Warranty.

1.5 QUALITY ASSURANCE

A. General Requirements:
1. Verification that the Electrical Contractor shall provide and install required raceways as specified in SECTION 26 05 33. Electrical Subcontractor shall install conductors provided by Subcontractors including CP, Communications, and I&C Subcontractors as specified in SECTION 13 47 13, SECTION 27 00 00, and SECTION 40 50 00. Terminations, testing, and commissioning shall be performed by the CP, Communications, and I&C Subcontractors.
2. Remote monitor and related LCP shall be provided, terminated, and tested by a Communications Subcontractor.

B. Senior Corrosion Technologist Qualifications: As specified in SECTION 13 47 13.

C. Manufacturer's Qualifications:
1. A minimum of 5 years of documented experience in the Work of this Section.
2. Provide certification that materials and components meet the requirements of the Contract Documents, include references for the applicable Sections and standard details.

D. Field Supervision: Provide an adequately experienced, competent Superintendent or Foreman to supervise the construction site and serve as the point of contact for the ENGINEER.

E. System Description:
1. Design requirements: Materials and equipment shall be new and the Manufacturer's latest standard design that complies with the specification requirements in accordance with NACE SP0572.
2. Performance requirements: Protect associated structure to criteria in accordance with NACE SP0169.

F. Show evidence of approval where UL standards exist and product listings are available.

G. The use of the Manufacturer's name and model or catalog number to establish a standard of quality and the general configuration desired.

H. General Requirements:
1. Submit documents required to obtain permits and pay fees required by the OWNER, the governmental agency having jurisdiction over the Work, and the AHJ. Arrange and notify the ENGINEER in writing of inspections required by the agencies. Furnish satisfactory evidence to the ENGINEER that Work is acceptable to the regulatory AHJs.
2. Obtain permits and pay the fees required by the OWNER, governmental agency having jurisdiction over the Work, and AHJ. Submit the documents required to obtain the permits required by the OWNER, governmental agency having jurisdiction over the Work, and AHJ. Arrange and notify the ENGINEER of the inspections required by these agencies. By the Final Completion date, furnish satisfactory evidence to the ENGINEER that the Work is acceptable to the regulatory AHJs.

I. Responsibility:
1. Equipment shall not exceed the sizes as shown on the Contract Documents without written approval from the ENGINEER. Costs incurred, structural analysis and modifications, due to an increase in equipment size shall be the responsibility of the CONTRACTOR.
2. Complete systems in accordance with the Contract Documents.
3. Coordinate the details of facility equipment and construction specification divisions that affect Work covered in the Contract Documents.
4. Provide incidental items not actually as shown on the Drawings or specified but which are required by good practice to provide complete functional systems.
5. The exact fitting of materials and equipment shall be the responsibility of the CONTRACTOR.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Coil the anode conductors and secure and package the anode in crates, as required, to prevent damage during shipping.

B. Ensure conductor is not damaged and that anodes or lead connections at the anode end are not physically stressed.

C. If anodes or conductors are damaged, replace the complete anode.

D. Coke Breeze:
1. Bulk or bag shipping.
2. Shipped and stored in a manner to keep it dry and minimize it from freezing solid.
3. If bagged, provide and ship in waterproof bags.
4. Bags shall be UV-resistant or protected with tarps to protect coke breeze from long-term UV exposure.

E. CP Material:
1. Store off the ground.
2. Protect against weather, condensation, and mechanical damage.
3. Handle with care.
4. Do not sharply bend or tightly coil the conductors.
5. Replace equipment or materials damaged in shipment or installation.
6. Immediately remove damaged materials from the Work site.
7. Reference electrodes:
a. Do not allow to freeze.
b. Store in a protected area.
c. Utilize before the specified storage stability period expires.

1.7 SITE CONDITIONS
A. Environmental Requirements: Store materials in covered and heated units to maintain minimum temperatures above the restricted temperature limits.
B. Materials and equipment shall be designed and constructed for continuous operation at rated current, at Project elevation, 104°F ambient, and 95% relative humidity.
C. Outdoor Equipment: Provide equipment and devices to be installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of -30°F to 104°F.
D. Inspection:
1. Drawings were developed from past As-Builts. Prior to submitting Bids or Proposals, verify dimensions and existing conditions including, but not limited to, structures, equipment, devices, conduits, etc.
2. Before submitting a Bid or a Proposal, the CONTRACTOR is required to determine conditions at the site and at existing structures to become familiar with existing conditions and electrical systems that will, in any way or manner, affect the Work required under the Contract. No subsequent increase in Contract Price will be allowed for additional Work required because of the CONTRACTOR's failure to fulfill this requirement.
3. Carry out any Work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such Work when approved by the ENGINEER.
4. During pre-construction activities, confer with the ENGINEER to verify, at each area of construction activity, the location of existing utilities, equipment, and structures and the requirements for adequately protecting them. Pay for required repairs if damage occurs during the Work.

1.8 WARRANTY
A. Warranty for 3 years from the Substantial Completion date for the satisfactory performance and installation of the rectifier and associated appurtenances.
B. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the ICCP for buried and submerged piping and structures system and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Manual or Automatic Potential Controlled Rectifier:
1. Universal Rectifier, Standard Air-Cooled Line
2. JA Electronics, Standard Air-Cooled Line
B. Anode Centralizers for Deep Well Groundbed and Vertical Anodes:
1. Farwest, Centra Series
2. Mesa, Cen Series
C. Coke Breeze for Deep Anode Type Groundbeds:
1. Loresco, SC-3, RS-3
2. Asbury 4518
D. Deep Anode Terminal/Junction Box:
1. Hoffman Engineering Company
2. Stahlin Brothers, Inc.
3. Universal Rectifier, Inc.
E. Splicing Products:
1. As specified in SECTION 13 47 13
F. Deep Anode Well Seal:
1. Berkeley Pump Company
2. Cambell Manufacturing, Inc.
3. Jacuzzi Brothers, Inc.
G. Bentonite Sealer:
1. Cathodic Engineering Equipment, Co., Inc., PermaPlug
2. Mesa, Enviroplug
H. Slotted Vent Pipe:
1. Loresco, AllVent
I. Remote Monitoring Radios:
1. As specified in SECTION 13 47 13
J. Deep Anode Junction Box Shunts:
1. Holloway Type RS 0.01 ohm Manganin Wire Shunt
2. M.C. Miller, Yellow, 0.01 ohm Shunt

3. Cott, Yellow, 0.01 ohm Shunt
4. Tinker & Rasor, Yellow, 0.01 ohm Shunt

2.2 MATERIALS

A. Manual Controlled Rectifier:

1. Mount an engraved nameplate on the interior of the door:
   a. List the Manufacturer's name and phone number, model number, year manufactured, serial number, and AC and DC electrical characteristics including voltage and amperage input and output electrical outlet ratings.
   b. Nameplates with only the Supplier's name and phone number in place of the Manufacturer's name and phone number will not be accepted and shall require replacement at no cost to the OWNER.
2. Description:
   a. Ambient air-cooled.
   b. Manually controlled.
   c. Coordinate with site conditions as specified in this Section.
   d. Designed to operate continuously at the full rated output at ambient conditions as specified in this Section.
   e. Single-phase, bridge type with silicon diode, capable of operation at 110% of the rated input/output without damage to the components.
3. Assembly components:
   a. Dual AC input of 208/480 V, single-phase or three-phase, 60 Hz and a suitably sized thermal magnetic type circuit breaker on the front of the panel.
   b. Suitably sized heat sinks to maintain the rectifying element and the case temperatures below the maximum temperature recommended by the Manufacturer.
   c. MOV surge protection and current and voltage limiting devices.
   d. Lightning protection devices on both AC output and DC output.
   e. Efficiency filter.
   f. Fine and coarse secondary taps with output controlled by a minimum of 20 evenly divided transformer tap settings; arrange in consecutive order.
   g. GFCI protected, 120 V convenience receptacle self-powered from rectifier unit.
   h. Proper sized pedestal for mounting.
   i. Remote monitoring terminals to provide AC power to remote monitor, as well as overall system voltage and current.
   j. Power on indication light.
4. Rectifier transformer:
   a. Separate and secondary type.
   b. The transformer is designed to operate properly at 115% of the specified rated output to allow for reserve capacity.
   c. Minimum efficiency: 95%.
   d. In accordance with NEMA and UL.
   e. Transformer insulation class and temperature rise: 356°F insulation system designed for full load operation at a maximum temperature rise of 239°F above 104°F ambient.
5. Meters and shunt:
   a. Meters:
      1) Combination DC voltage current.
      2) D'Varsonal movement type.
      3) Individual switches so that the meter is not in circuit continuously.
      4) Accurate to within 2% of actual voltage and current output.
      5) On/off switch.
      6) Tested and calibrated at the factory.
      7) Test in the field for accuracy.
      8) Have inaccurate meters replaced by the Manufacturer.
      9) Scaled to measure the full scale of the rectifier output plus 25%.
   b. Shunt:
      1) External panel-mounted.
      2) Holloway type.
      3) In series with ammeter.
      4) Clearly identify shunt voltage and amperage.
6. Rectifier panel board:
   a. Mount rectifier meters, shunt, AC circuit breaker, taps, AC and DC fuses, and DC output terminals.
   b. Nonmetallic.
   c. Construct of sufficient thickness to withstand shipping and operational stresses.
   d. Locate at the front of the rectifier to allow access for testing and adjustment.
7. Rectifier DC terminals: Solderless lug type.
8. Tap studs, tap bars, nuts, and washers: Suitably sized brass, bronze, nickel, or tin-plated copper.
9. Clearly engrave or identify the polarity of the rectifier DC terminals, fine and coarse transformer tap numbering, meters, and fuses with a permanent marking system on the rectifier panel; stick on labels or tape are not acceptable.

10. Provide an enclosure for the transformer, AC and DC circuit breakers, rectifier stacks, lightning arrestors, DC output meters, and wiring connections:
    a. Material: Minimum 11 gauge steel.
    b. Finish: Hot-dipped galvanized or baked enamel.
    c. Color: To be selected from the Manufacturer's full color range.
    d. Air-cooled.
    e. In accordance with NEMA 3R.
    f. Suitable ventilation for adequate cooling of the rectifier by natural air convection.
    g. Protect interior components from weather, vandalism, and nest building insects.
    h. Provide:
        1) A grounding lug on the outside of the cabinet.
        2) Hinged and removable doors on the front and on both sides to allow access.
        3) SST steel latches and a hasp for padlocking.
    i. For air-cooled standard type rectifiers up to 25 A DC output, provide one size larger case than is standard for the rectifier rating to aid in cooling and access for testing and maintenance.
    j. For 26 A DC output size rectifiers or larger, provide with a standard size case.
    k. Power on indicating light.
11. Clearly label conductors and wires corresponding to the Shop Drawings and clearly defining the respective voltage system, AD/DC/control. Provide slip-on, heat-shrink wire labels for wires.

B. Automatic Potential Control Rectifier (Alternate):
1. Description, same as manual controlled except solid-state automatic potential controlled with a manual controlled option.
2. Assembly components:
    a. Manual control taps as backup.
    b. Thermostatically controlled fan.
    c. Ventilation barriers.
    d. PRE as specified in SECTION 13 47 13.

C. AC Power Service: Provide as shown on the Drawings.

D. Groundbed:
1. Install 25 type 2684Z anodes in each groundbed, spaced 10 feet to 15 feet apart. Provide a minimum groundbed depth of 415 feet, active length shall be 265 feet, minimum, and inactive length shall be 145 feet, minimum.
2. Chill cast anodes: High silicon, chromium iron alloy, manufactured in accordance with ASTM A 518, Grade 3 with chemical composition percentages as follows:

Element	Composition, Weight Percentage
Carbon	0.70 to 1.10
Manganese	1.50 maximum
Silicon	14.20 to 14.75
Chromium	3.25 to 5.00
Molybdenum	0.20 maximum
Copper	0.50 maximum

    a. In tubular form with hollow, straight walled design.
    b. Do not exceed 1/4 inch bowing and deformation tolerances over the length of the anode.
    c. Solid walls of uniform thickness with an open cylindrical interior:

Type	Weight (lbs)	OD (inches)	Length (ft)
2284	48	2.2	7
2684	48	2.2	7
3884	94	3.8	7
4884L	128	4.8	7

3. Anode lead wire connection:
    a. Attach at the center of the anode.
    b. Minimum pull-out strength: 1 1/2 times the breaking strength of #8 AWG lead wire or 788 lbs for the center connection.
    c. Do not exceed 0.004 ohms for electrical contact resistance as measured across lead wire-to-connector junction.
4. Anode centralizers for deep well groundbed and vertical anodes:
    a. Description: Either a metal or a plastic assembly that can be securely attached to the anode without damaging or impairing the function of the anode or the anode wire.
        1) Size and type: Such that they will center the vertical anode in a drilled hole and provide for easy field adjustment.
        2) Minimum of three vanes to keep the center anode in the hole.
    b. Do not block the hole or impair installation of the anode, anode lead wire, vent pipe, or coke breeze.

5. Anode backfill:
   a. Coke breeze for the backfill of groundbeds: Low resistance, less than 0.10 ohm-cm, electrically conductive, calcined petroleum type approved for direct burial by the appropriate local authorities.
   b. Coke breeze for surface and distributed type groundbeds:

Coke Breeze Requirements	
Calcination Temperature	1,250°C, minimum
Actual Carbon	91, maximum
Particle Size	1-mm diameter, maximum
Bulk Density	55 lbs/cf to 75 lbs/cf, minimum
Fixed Carbon	99% by weight, minimum

   c. Coke breeze for deep anode type groundbeds:
      1) Suitable for pumping.
      2) Calcined.
      3) No de-dusting oils used during manufacturing.
6. PREs: CSE material as specified in SECTION 13 47 13.
7. CP test stations: As specified in SECTION 13 47 13.
8. Exothermic weld materials: As specified in SECTION 13 47 13.
9. Exothermic weld caps: Coating materials as specified in SECTION 13 47 13.
10. Deep anode terminal/junction box:
    a. NEMA 3X or 4X type junction box, standard product of the recognized Manufacturer.
    b. Material: Minimum 14 gauge steel.
    c. Minimum inside box dimensions: 16 inches by 12 inches by 6 inches deep or larger, if required to provide proper access for the number of anodes specified.
    d. Finish: Coated with either baked enamel or heat-cured 100% solids thermosetting epoxy coating.
    e. Provide with:
       1) One piece of oil-resistant gasket to be mounted inside the door to form an oil-tight and dust-free seal.
       2) A locking lid and a hasp for a padlock.
       3) Separate back panel:
          a) For the attachment of a bus bar with a terminal strip or terminal block with medium-duty solderless compression type terminal connectors.
          b) Accommodate the anode wire and the rectifier positive header wire gauge specified with the necessary mounting hardware.
          c) Material: A minimum 3/16-inch micarta or cross-laminated phenolic sheet.
       4) Sufficient copper shorting straps and 0.01 ohm Holloway Type RS shunts to electrically bond each anode lead terminal to the rectifier positive lead bus bar as shown on the Drawings.
       5) A minimum number of shunts and compression type connectors to match the number of anodes provided for each groundbed location.
       6) Rugged supports on the enclosure to allow it to be securely wall-mounted as shown on the Drawings.
       7) Double hub suitable for thread mounting in two, 1 1/4 inch or larger rigid threaded RGS conduit.
11. Hardware:
    a. Flat and split washer, terminal nuts, and studs: 1/4 inch.
    b. Finish: Nickel-plated brass or bronze.
12. Conduit, locknuts, and straps: Install conduit, fittings, and wires in PVC-coated, rigid, hot-dipped galvanized steel conduit, as shown on the Drawings.
13. Plastic conduit for CP sheathing:
    a. Diameter: 1 inch.
    b. Schedule 40 PE or PVC plastic pipe.
14. Wire:
    a. CP wires and cables: Insulated stranded copper wire.
    b. Wire size, type, and insulation type: As specified in this Section and SECTION 13 47 13.
    c. Joint bond and CP cables and test leads, #2 AWG, #4 AWG, #6 AWG, #8 AWG, and #12 AWG:
       1) Single-conductor, stranded copper wire with #12 AWG being solid copper.
       2) Insulation:
          a) HMWPE: 600 V.
          b) Minimum thickness in accordance with ASTM D 1248, Class C, Grade 5: 7/64 inch.
    d. Anode lead wire:
       1) #8 AWG, 7 strand, copper conductor with Kynar polyvinylidene and HMWPE PE jacket.
       2) Insulation:
          a) HMWPE: 600 V.
          b) Minimum thickness in accordance with ASTM D 1248, Class C, Grade 5: 7/64 inch.
    e. Test lead and wire reference electrode wire: As specified in SECTION 13 47 13.
    f. Length: Sufficient to reach anode terminal box without splicing additional wire.
    g. Wire insulation color: Indicate the function of each wire as shown on the Drawings and as specified in SECTION 13 47 13.

15. Deep anode junction box shunts:
    a. Holloway Type RS 0.01 ohm manganin wire shunt with 5 A capacity or MCM Miller, yellow, 0.01 ohm shunt, Cott or T and R, yellow, 0.01 ohm shunt with 10 A capacity.
    b. Resistance: 0.01 ohm.
    c. Capacity: 5 A minimum.
16. Electrical connectors: Tin or nickel-plated copper, brass, bronze, or SST for electrical conductivity and atmospheric corrosion resistance.
17. Rectifier location marking tags:
    a. Stamped brass or aluminum.
    b. Stamped letters and numbers shall be 1/8 inch minimum size.
    c. Stamp with rectifier number and pipeline station describing the location of the rectifier.
18. Pipe coating repair: Materials as specified in SECTION 13 47 13.
19. Downhole vent pipe for deep anode groundbeds:
    a. Material:
        1) Heavy duty Schedule 40 PVC.
        2) Diameter: Minimum 1 inch.
        3) In accordance with ASTM D 1785, Type 1, Grade 1.
        4) Resistant to chlorine.
        5) Either drilled and provided with geotextile fabric sock or slotted.
20. Deep anode well seal: Two-piece, CI well seal with rubber packer to form a watertight seal.
21. Well casing:
    a. Use when anode replaceability is desirable or environmental sealing requirements are necessary.
    b. Material:
        1) Standard weight PVC, minimum Schedule 40.
        2) Plastic casing: In accordance with ASTM F 480.
        3) Good condition, durable, and watertight.
        4) Non-toxic, resistant to water and soil corrosiveness.
        5) Meet local authority well drilling standards and withstand installation, grouting, and operating stresses.
    c. Nominal wall thickness for 6 inch or larger diameter steel casing: 1/4 inch thick.
22. Sealing material:
    a. Impermeable material, such as cement grout, bentonite-gelatinous mud, or grout or puddling clay as required to meet local authority drilling code requirements.
    b. Cement grout sealer:
        1) Composed of a maximum of two parts by weight of sand and one part of cement with 5 to 7 gallons of clean water (per 94 lb bag of cement).
        2) Quick-setting cement, retardants to setting, and other additives, including hydrated lime to make the mix more fluid (up to 10% of volume of cement) and up to 5% bentonite to make the mix more fluid and to reduce shrinkage, may be used.
    c. Bentonite sealer:
        1) High-swelling, chemically unaltered bentonite clay intended for plugging and sealing drilled holes.
    d. Puddling clay sealer:
        1) A mixture of bentonite, other expansive clays, fine-grained material and water, in a ratio of no less than 7 lbs of bentonite or expansive clay per gallon of water.
        2) Composed of a minimum of 50% expansive clay with the maximum size of the remaining portion not exceeding that of coarse sand.
23. Gravel for deep anode groundbed:
    a. Use if allowed by state regulation.
    b. Thoroughly washed, sound, durable, and well-rounded gravel: 1 1/2 inch to 3/4 inch.
24. Deep anode surface vent pipe:
    a. 1 inch diameter steel pipe with 180 degree gooseneck.
    b. Predrill end cap with a minimum of six evenly spaced 1/8 inch diameter holes.

E. Impressed Current CP System Enclosure:
1. Provide a NEMA 3R enclosure for rectifier, panelboard, remote monitoring system, and associated components.
    a. Provide an open bottom.
    b. Lockable with padlock.
    c. Roof with overhang and soffit to prevent dripping onto doorway. Minimum overhang shall be 3 1/2 inches.
    d. 2 door access from the front of the cabinet.
    e. Provide channels for internal conductor raceways.
    f. Exposed exterior hardware shall be SST.
    g. UL approved as a complete system.
2. Powder coated steel, minimum 12 gauge.
3. Color: ANSI 61, light gray finish.

PART 3 EXECUTION

3.1 GENERAL

A. Complete anode assembly, wire connections, anode placement, coke breeze installations, and backfill operations during daylight conditions.

B. Install corrosion protection system components (e.g., splices, bonds, and wire installation) when ambient temperature is above 15°F and rising to minimize damage to materials and insulation.
C. Do not cadweld or utilize open flame or torches in areas of flammable vapors or airborne particles where a fire or explosion could result.
D. Install and work around above grade and buried AC power and control lines and water, process, oil and gas pipelines with extreme care; follow the minimum separation distances in accordance with other utility requirements and regulations.
E. Do not work next to power lines during times of high lightning activity.
F. Provide AC power service as shown on the Drawings.
G. Provide labels and identification for conductors as specified in SECTION 26 05 19.

3.2 INSTALLATION

A. Rectifier:
1. Provide rectifier, entrance, switch, and electrical hardware.
2. In accordance with NFPA 70, local utility company requirements, the AHJ, and applicable codes and standards.
3. Installation and locations as shown on the Drawings.
4. Mounted to allow unobstructed access to and full opening of rectifier access doors for testing, maintenance, and repair.
5. Install level and plumb.
6. Ground rectifier case and AC entrance switch with a separate ground rod, other than for AC service.
7. Install rectifier cables in PVC-coated rigid galvanized steel conduit.
8. Terminate conduits with plastic-throated conduit bushings.
9. Identify with a stamped identification tag permanently attached in a visible location on the inside of the rectifier housing.
10. Stamp tag with the rectifier number and the pipeline stationing of the rectifier location.
11. Install rectifier wire from the rectifier negative terminal directly to the pipelines or through a junction box as shown on the Drawings.
12. Install wire rectifier positive terminal to the anode terminal box or the anode header wire junction box as shown on the Drawings.
13. Clearly identify groundbed and structure leads in the rectifier case and boxes.
14. Install a PRE as specified in SECTION 13 47 13.
    a. Extend the electrode lead wire up to and terminate inside the rectifier housing at an accessible location on the front of the rectifier panel.
    b. Locate the electrode lead wire in a manner to avoid future excavation damage.

B. Deep Anode Groundbed:
1. Perform drilling, electrical logging of hole, lowering of anodes, coke breeze placement, and backfilling in a continuous operation.
2. Ensure the process is observed by the ENGINEER in the prescriptive method that follows.
3. Submit procedures if alternate methods are used.
4. Construct holes and set casings round, straight, and plumb.
5. Seal as specified herein or as required by local well drilling regulations; the most stringent requirements shall apply.
6. Take necessary precautions to avoid contamination of the aquifer with contaminated water, gasoline, drilling fluids and additives, or other deleterious substances during construction, through opening, or by seepage through ground surface.
7. For deep anode groundbeds, maintain a log describing depth and type of geological formations encountered during drilling; submit copies of the log to the ENGINEER and the local authority.
8. Take precautions to avoid the entrance of foreign matter into the hole, the movement of soil strata, or the collapsing of the hole during progress of Work.
9. If the movement of soil strata or the collapse of the drilled hole interfere with proper installation, recover wire and anode strings and ream or re-drill the hole at the CONTRACTOR's expense.
10. Drilling:
    a. Drill a minimal nominal depth as shown on the Drawings.
    b. Over-drill the hole depth as required to compensate for sloughing during anode installation such that top of the active column is not less than the minimum separation distance below the ground surface as shown on the Drawings.
    c. Drill fluid: Non-hazardous, bentonite based, water well type drilling gel or mud.
    d. Drilling mud: Certified by NSF as non-hazardous.
    e. Locations:
        1) Drill at the approximate locations shown on the Drawings.
        2) Exact locations will depend on the locations of structures and utilities encountered in the field and shall be determined in the field with the ENGINEER prior to the start of construction.
    f. Over-drill the hole and install surface casing as shown on the Drawings:
        1) Do not install casing, other than surface casing, unless necessary for the successful completion of the hole.
        2) Set surface casing prior to completion of the first 70 feet of the hole.
        3) Steel casing installation: Cut below the surface and jack up to point 50 feet, minimum, above the top of the active column.

4) Complete cutting and jacking operations before or after the installation of the anode assembly.
5) Plastic casing may be installed in the inactive column area.

g. Sealing:
1) Seal annular space around the surface casing and soil in accordance with local authority well drilling regulations.
2) Sealing material shall reach initial set before any additional Work on the drilled hole that may disturb the seal will be allowed to continue.
3) Seal the hole to prevent downhole movement of surface water and the intermixing of different aquifers.
4) Where separate aquifers are encountered, install a bentonite seal between the different aquifers.
5) Bentonite seal thickness shall be a minimum of 3 feet.
6) Increase seal thickness as required to maintain the separation of aquifers under high pressure or artesian conditions.
7) If different aquifers are encountered in the active anode area, install separate vent pipes in areas between different aquifers.

h. Contain and dispose of drilling mud and cuttings in a legal manner.
i. Field dug mud pits or sumps are acceptable depending on the location and with prior written approval of the ENGINEER.
j. Filled mud pits will only be considered, if they are completely pumped and cleaned out following drilling operations and then backfilled and compacted correctly to not cause settlement or soft areas in the future.

11. Anode bed loading preparation:
a. Provide the ENGINEER a minimum of 1 day notice prior to final anode hole preparation and anode and coke breeze placement.
b. Provide sufficient coke breeze to backfill completely around anodes as shown on the Drawings with allowances for extra volume due to cave-ins, wash-outs, and excavation or installation methods.
c. Complete the final preparation of the anode hole, electrical logging, lowering of anodes and vent pipe, coke breeze backfill, and placement of seals only during daylight hours and when observed by the ENGINEER.
d. When holes are drilled to the specified depth, circulate clean water in the hole to clear it drilling mud and cuttings.
e. Recirculate sufficiently to allow the settling of coke breeze without causing danger of anode hole collapse or wall sloughing.
f. Schedule Work of anode bed loading preparations and assembly early in the day.
g. Do not begin flushing and anode loading after 2:00 p.m. without prior written approval of the ENGINEER.

12. Electrical logging:
a. Flush the hole and electrically log the hole in the presence of the ENGINEER to determine downhole soil layer electrical characteristics for optimum anode evaluation.
b. Make a resistance-to-earth reading as a short section of pipe or as the test anode is lowered down the hole.
c. Testing will require suitable meters; a short section of weighted pipe or test anode; connection to a low resistance ground; a wire reel with the appropriate type, size, and amount of wire to reach the bottom of hole; and a method to determine the depth of weighted pipe or the anode below surface.
d. The current source shall be a minimum 12 VDC equipped with a shunt to measure current through the shunt.
e. The use of a soil resistivity meter is not an acceptable method to log the drilled hole.
f. Record resistance readings and depth from the bottom of the surface casing to the bottom of the hole continuously or at 5 foot increments for the entire hole depth; log hole and test anode or short piece of pipe removed prior to inserting the first anode and the vent pipe.
g. Based on the results of electrical log data and the driller's log of soil formations, the ENGINEER may modify anode spacing and drilling depth.

13. Lowering of anodes:
a. Lower anodes after drilling, the ENGINEER's review of the driller's log, and the electrical logging of the hole are completed.
b. The actual lowering of anodes and backfilling of the hole with coke breeze shall be observed by the ENGINEER.
c. Delay installation of anode assembly and coke breeze until the next day if it cannot be completed during daylight of the same day as the completion of drilling and electrical loggings.
d. If installation of the anode assembly is delayed more than 4 hours from completion of drilling operations, reinsert drill stem and bit and run back to the bottom of the hole.
e. Maintain sufficient bit rotation and circulation to ensure the drilled hole is adequately prepared for anode and coke breeze installation.
f. Place a minimum of one centralizer with three ribs or flights on each anode and adjust to fit down the hole and not cause damage to the wire insulation while keeping the anode in the center of the drilled hole.
g. Place three centralizers, ribs, or flights 120 degrees apart.
h. Do not damage the anode when attaching the centralizers; do not leave sharp edges or corners that may damage wire insulation.
i. If metallic centralizers are used, tape ends to minimize possible damage to wire insulation.
j. If a hole is drilled with mud, flush the hole with clean water in a continuous process before or after anodes are lowered until the return fluid is sufficiently clear to allow for the proper installation and settlement of anodes, vent pipe, and coke breeze.
k. The ENGINEER will inspect the return fluid before coke breeze installations can begin.

l. Maintain the hole full of water during the installation of the anodes and coke breeze backfilling.
m. Lay out anode leads and vent pipe to prevent damage, allow inspection, and to allow ease of downhole installation.
n. Attach centralizers to each anode prior to lowering down the hole.
o. The ENGINEER will inspect anodes and lead wires for damage.
p. Damage to anodes or lead wires is cause for rejection of that anode assembly.
q. Measure the anode lead wire length to verify and monitor actual anode depth and spacing in the drilled hole by one of the following methods:
    1) Measure anode lead length as the individual anode is lowered down the hole with a wire measurer to confirm actual anode elevation and spacing.
    2) Pre-measure the anode length and compare it to other anode lengths for reference; lay out anode leads, measure actual anode wire length, and pre-mark them to demonstrate actual wire lengths and show that the difference between end of wires are equal to specified spacing.
r. If a predrilled vent is used, encase it in a geotextile sock and secure the sock with two complete wraps of tape on each end of the 20-foot pipe section.
s. If slotted vent pipe is used, a geotextile sock is not required.
t. For deep anode groundbeds, first attach the deepest anode to the predrilled or slotted vent pipe; seal weight with a cap or plug.
u. After electrical logging is complete, carefully lower the anode and the vent pipe to the bottom of the hole.
v. Wipe vent pipe individual ends clean and dry, and glue with solvent type cement.
w. Solvent type cement and primer shall be designed to be suitable for similar fast set, immersion service, and joining of PVC.
x. Clean, prime, glue, rotate the connection, and allow to sufficiently dry before the vent pipe is lowered.
y. Lower remaining anodes individually.
z. Monitor individual anode depth and spacing.
aa. Maintain sufficient slack in the anode lead cables to prevent damage during anode installation and backfilling operations.
bb. When the anode is at the specified depth, suspend in the hole and securely tie off around the suspension bar or the pipe with a sufficient diameter 2 1/2 inches minimum to prevent sharp bending of wires.
cc. Tie wires off in order.
dd. Keep anodes securely fastened until the coke breeze backfill has been placed and has settled.
ee. Take care to avoid damage to anode assembly and wires from casing or drill rig.
ff. During installation, if any anode is damaged or wire insulation is cut, gouged, or scraped, the anode and wire shall be replaced.
gg. No wire splices will be allowed except those shown on the Drawings and approved by the ENGINEER.
hh. Elevation and spacing of anodes shall be as shown on the Drawings unless the ENGINEER modifies the anode depth and spacing in the field based on the driller's geological and electrical logs.
ii. If directed by the ENGINEER, modify anode elevation by installing a gravel layer below the first anode or by over-drilling the hole.
jj. If needed, flush the hole to allow for the installation and settlement of the gravel layer for anode location adjustment.

14. Backfilling of the anode hole:
    a. After the anode assembly is installed to the predetermined depth, place the coke breeze column around the anodes by pumping.
    b. Thoroughly mix with water to prepare coke breeze slurry in accordance with the Manufacturer's instructions.
    c. Pump coke breeze slurry in the hole at high pressure through an additional plastic pipe.
    d. Install plastic pipe in the drilled hole before or after the first anode and vent pipe assembly is installed in the drilled hole but before the remaining anodes are installed.
    e. Pump in an even and continuous manner around each anode from the bottom of the hole to the top as the pipe is slowly and carefully withdrawn.
    f. Take care not to damage pipe or to remove pipe too fast.
    g. Continue the pumping operation in continuous operation when started.
    h. Install a sufficient amount of coke breeze to cover the top anode as shown on the Drawings.
    i. Conduct resistance measurements between the appropriate grounded structure or pipeline and each individual anode lead as coke breeze is pumped into the drilled hole.
    j. Start individual anode resistance measurements with the bottom anode first.
    k. When the resistance measurement indicates that the coke breeze level has covered the first anode, connect the test leads to the next higher anode lead wire and repeat the resistance measurement.
    l. Conduct resistance testing consecutively for each anode as the coke breeze is installed.
    m. Utilize resistance measurements to monitor the coke breeze level in the drilled hole and detect any possible coke breeze bridging problems during the pumping process.
    n. After the coke breeze has been placed and settled and the anodes have become substantially set, measure the electrical resistance of the individual anodes again to verify that no bridging occurred.
    o. Do not move the anode by pulling up on lead wire.
    p. Measure, record, and submit initial and final individual anode resistance-to-earth for each drilled location.
    q. Take care to not damage the anode assembly and to avoid plugging the vent pipe, bridging of coke breeze, collapsing of the hole, and over-filling or under-filling the hole.

r. If the hole collapses, coke breeze bridges, vent pipe plugs, anode assembly is damaged, or the hole is under-filled or over-filled, take the necessary steps to resolve and correct the problem at the CONTRACTOR's expense.
s. After the coke breeze is installed and has settled for a minimum of 1 day and anodes are set, measure the depth to the top of coke breeze column to ensure coke breeze is at the elevation shown on the Drawings to maintain sufficient cover for anodes and electrical isolation from the structure to be protected.
t. If the hole is over-filled by more than 15 feet, remove coke breeze to provide the elevation shown on the Drawings.
u. If the hole is under-filled by more than 5 feet, add additional coke breeze to the elevation shown on the Drawings by hand shoveling a saturated mixture of coke breeze and water to bring the coke breeze level up to the depth shown on the Drawings.
v. Upon acceptance of the coke breeze installation, either add 1 1/2 inches of washed gravel, if allowed by local authorities, or drill cuttings, bentonite clay, or cement to fill the hole to depth shown on the Drawings to seal the deep anode hole as required by local authorities and the Contract Documents.

15. Placement of seal:
    a. The ENGINEER will measure the elevation of the gravel.
    b. Upon acceptance of washed gravel or top coke breeze elevation, place sealing material from the top of the gravel backfill or coke breeze to a point 12 inches below the finished elevation of well seal or hole termination depth shown on the Drawings or as required by local authority well drilling regulations.
    c. The method of seal placement shall force the sealing material from the bottom of the space to be sealed to the surface.
    d. Place sealing material in a manner that ensures the entire filling of the space in one continuous operation.
    e. Complete vent pipe and lead wire termination prior to the placement of the seal inside the casing.
    f. Conduit and vent pipe penetrations through the seal are allowed if rubber packing is used to seal the annular space watertight.
16. Vent pipe:
    a. Seal the bottom of the vent pipe with a plastic end cap or plug.
    b. Drilled vent pipe holes:
        1) Diameter: 3/8 inch.
        2) Holes to penetrate pipe at four quadrants around the circumference at each drilled location and space equally at 4 inches apart throughout each perforated 2-foot section.
    c. Wrap in geotextile fabric sock to prevent intrusion of fine-grained coke breeze into vent pipe:
        1) Nilex filter sock.
        2) Non-deteriorating geotextile material of sufficient durability and attachment to the pipe to resist tearing and damage during installation.
        3) Thread above the grade end of the steel vent pipe, 3 inches to 6 inches, and install threaded screened bushing, drilled plastic, or steel and cap to prevent entry into or blockage of the vent pipe by foreign objects or insects.
    d. Slotted vent pipe:
        1) Vertical slits approximately 0.006 inch wide and 1 1/2 inches long cut in a parallel pattern to longitudinal centerline of the plastic pipe.
        2) Slot spacing: 1 inch from the preceding slit at approximately 6 inch centerline separation distance.
    e. Extended from the bottom to the top of the drilled hole.
    f. Perforated in a continuous manner such that perforated sections are adjacent to anodes for the entire active anode column length upon installation.
    g. Terminate at the top of the anode hole or at the rectifier pole as shown on the Drawings.
    h. Above grade portion of the 1-inch vent pipe: Steel surface vent pipe as specified in this Section.
    i. Connect steel vent pipe to the plastic downhole vent pipe with the appropriate plastic-to-steel coupling.
    j. Terminate a minimum of 24 inches above grade and 12 inches above the known floodplain elevation.
    k. Install a 180 degree gooseneck on the steel vent pipe and a cap with predrilled end cap or a screened bushing.
    l. Place the well cap in the casing and tighten bolts to torque in accordance with the Manufacturer's instructions.
17. Anode terminal box: Installed in the ICCP building at the top of the deep anode groundbed as shown on the Drawings.
18. Anode lead wire termination:
    a. Terminated in anode terminal box as shown on the Drawings.
    b. Connect rectifier positive wire and anode lead wires with appropriate shunts and copper bus bars.
    c. For deep anode groundbeds, cut a smooth round hole in the side of the surface casing for routing of the anode lead wires as shown on the Drawings.
    d. Grind or file edges smooth.
    e. Provide and install a suitable type and size of rubber or plastic grommet fitting at the casing wall to protect anode lead wires from damage.
    f. Label wires in the boxes with permanent non-ferrous tags identifying the anode number and the rectifier lead.
    g. Connect numbered anode leads in consecutive order to the anode terminal starting with the bottom anode as Number 1 at the top left hand junction box terminal.

C. Test Station: Install the rectifier location as specified in SECTION 13 47 13.

D. Conduits and Junction Boxes:
   1. Wires installed above grade:
      a. Install wires in PVC-coated RGS conduit and fittings.
      b. Secure wires with double hole conduit straps with wood screws on wood bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded and threaded studs on steelwork.
   2. Wires installed below grade: Install wires in PVC-coated RGS conduit and fittings.
   3. Mount boxes and exposed conduit plumb and level.
   4. Install in a secure, substantial manner by attachment to the appropriate wood post, channel, service pole, building structure, or structural member.
   5. Threaded studs driven in by powder charge and provided with split washers and nuts are acceptable. Use expansion shields.
   6. Secure conduits entering cabinets, junction, or terminal boxes with double galvanized locknuts, one on the inside and one on the outside of the box and with bushings.
   7. In outdoor, underground, or buried locations, use watertight couplings, and connections.
   8. Open no more knockouts in the box than required.
   9. Seal unused openings.
   10. Install to prevent water from entering the conduit or the box.
   11. Install insulated bushings and insulating throat connectors on the ends of PVC-coated RGS that terminate in test stations, junction or terminal boxes, and rectifier cabinets.
   12. Make PVC-coated RGS watertight and free of obstructions.
   13. Ream PVC-coated RGS, remove burrs, degrease and paint threads, and clean the conduit interior before introducing cables or pull wires.
   14. Use elbows for bends 30 degrees or larger.
   15. Solvent weld plastic conduit joints with solvent recommended by the Conduit Manufacturer.
   16. Follow the Manufacturer's instructions and provide watertight joints.
   17. Use acceptable plastic terminal adapters and female adapters when joining plastic conduit to metallic fittings or conduit.

E. Buried Conductors:
   1. Install raceways for conductors as specified in SECTION 26 05 33.
   2. Install test leads and rectifier leads from the negative rectifier terminal to the pipeline; attach by exothermic weld method to pipe.
   3. Install rectifier leads from the positive rectifier terminal to the anode junction box as shown on the Drawings.
   4. Apply red electrical tape to the positive lead wire a maximum of 3 inches from the positive rectifier connection for identification purposes.
   5. Bury CP cables and wires a minimum of 36 inches below finished grade.
   6. Only splices shown on the Drawings or approved by the ENGINEER are permitted on rectifier leads and anode header wires.
   7. Insulation on wires shall be free of cut or abraded areas.
   8. Avoid damage to existing structures, pipelines, and utilities during the trenching process.
   9. CP cable trenches:
      a. Locate and route as shown on the Drawings.
      b. Modify location to minimize possible damage to existing structures; obtain approval for modification.
      c. Uniform depth and width, level, smooth, and free of any sharp objects.
      d. Hand trenching may be required in some areas to avoid damage to existing structures.
   10. Warning tape:
      a. Bury approximately 12 inches above underground CP cable.
      b. Align parallel to and within 2 inches of centerline of conduit or cable run.

F. Conductors in Boxes:
   1. Do not damage wire, insulation, or conduit during the installation process.
   2. Route and maintain sufficient slack in cables and wires to prevent the conductor from being unduly stressed, damaged, or broken during installation or backfill operations.
   3. Do not exceed the Cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
   4. Where a pulling compound is used, use only a UL listed compound compatible with cable outer insulation and the conduit type involved.
   5. Wires:
      a. Installed in continuous length, free of splices, except those approved by the ENGINEER.
      b. Insulation: Free of cut, damaged, or abraded areas.
      c. If field conditions dictate that a splice is required or wire is damaged, repair splices or damage to wire insulation at the discretion of the ENGINEER. Use a waterproof splice kit for splices as specified in SECTION 13 47 13.
      d. Replace wire and insulation with damage.
      e. Splice and wire insulation repair shall be approved by the ENGINEER.
   6. Arrange wiring neatly in the rectifier, the test station, and the junction or terminal box; cut to proper length; remove surplus wire and attach the terminal or connect to the junction box or the rectifier terminal as specified.

7. Provide CP cables, test station, and reference electrode wires with sufficient slack and looped or coiled at the pipeline and the boxes to prevent wire from being unduly stressed or broken during backfilling operations.

G. Exothermic Weld Wire Connections: Use for the electrical connection of copper wire to metallic surfaces as specified in SECTION 13 47 13.

H. Wire Connection Coating: As specified in SECTION 13 47 13.

I. PRE: Install as specified in SECTION 13 47 13.

J. Abandonment of Deep Anode Groundbed:
1. Remove and dispose of building materials, rectifier, junction box, and conductors as shown on the Drawings.
2. Ensure the ENGINEER observes the process.
3. Seal as specified herein or as required by local authority drilling regulations; the most stringent requirements apply.
4. Avoid contamination of the aquifer with contaminated water, gasoline, drilling fluids and additives, or other deleterious substances during construction through opening or by seepage through the ground surface.
5. Take precautions to avoid the entrance of foreign matter into the hole, the movement of soil strata, and the collapsing of the hole during progress of the Work.
   a. Sealing:
      1) Seal annular space around the surface casing and soil in accordance with state requirements and local well drilling regulations.
      2) Allow sealing material to reach initial set before continuing additional Work on the drilled hole that may disturb the seal.
      3) Seal the hole to prevent the downhole movement of surface water and intermixing of different aquifers.
      4) Where separate aquifers are encountered, install a bentonite seal between the aquifers.
      5) Bentonite seal thickness shall be a minimum of 3 feet.
   b. Contain and dispose of drilling mud and cuttings in a legal manner.
6. Placement of seal:
   a. The uppermost 5 feet of casing shall be filled with grout or a permanent watertight cover.
   b. Place sealing material from the top of the gravel backfill or the coke breeze to a point 12 inches below the finished elevation of the well seal or the hole termination depth shown on the Drawings or as required by local authority well drilling regulations.
   c. The method of seal placement will force sealing material from the bottom of the space to be sealed to the surface.
   d. Place sealing material in a manner that ensures the entire filling of space in one continuous operation.
7. Conduits and junction boxes:
   a. Wires installed above grade: Cut below grade and remove.
   b. Wires installed below grade: Cut and remove.
   c. Remove mounted boxes and exposed conduit.

K. ICCP System Enclosure:
1. Mount rectifier, junction box, remote monitoring radio, and any required appurtenances for a complete system in enclosure.
2. Seal bottom as specified in SECTION 07 92 00.
3. Neatly route conductors in raceway channels. Provide flexible conduit for exposed conductors inside enclosure that do not fit in channels. Groundbed wires shall be routed directly into the junction box and shall not be enclosed in conduit.
4. Anchor enclosure to concrete pad using 18-8 minimum SST anchor bolts.

3.3 QUALITY CONTROL

A. Installation is not complete until AC and DC wiring is complete and the rectifier is capable of operating at the full rated capacity.

B. Leave AC to the rectifiers off and the rectifiers turned off during the installation of CP groundbeds.

C. Keep AC power, entrance switches, and rectifier enclosures secured with padlocks and safely turned off until operation tests are performed in the presence of the ENGINEER.

D. Preservation, restoration, and cleanup:
1. Keep the site neat and orderly.
2. Remove excess equipment and cuttings daily.
3. Contain and remove excess materials, mud, waste, products, and tailings.
4. Confine operations to construction easements and Work areas.
5. Restore the Work site to a condition equivalent to the condition to the satisfaction of the ENGINEER.
6. Prevent contamination of Work area:
   a. Do not dump or spill oil, fuel, solvents, coatings, rubbish, or similar materials on the ground or in or near streams or wetland areas.
   b. Prevent stream or groundwater contamination.
   c. Provide containment for and remove excess materials, drilling mud, and waste products from the site as necessary to meet the local road and highway requirements and the permit and easement conditions.
   d. Contain and cleanup contamination to any aquifer, stream, or soil at the CONTRACTOR's expense.
7. Upon the Substantial Completion date, remove materials, scraps, and debris from the premises and from the interior and exterior of devices and equipment.
8. Touch up scratches, scrapes, and chips in the interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.
9. If extensive damage to equipment paint surfaces occurs, completely refinish to equal or better than factory finish.

10. Correct damage to existing structures or utilities at the CONTRACTOR's expense.
11. Repair damage to concrete and asphalt sidewalks, curbs, roads, and driveways.
12. If subsequent trench or undercrossing settlement, cracking, subsidence, or other indication of failure occurs within the warranty period, promptly repair or replace at the CONTRACTOR's expense.

E. Testing:
1. Additional testing as specified in SECTION 13 47 17.
2. Impressed current anode: An anode will be selected at random for the CONTRACTOR to conduct, at the CONTRACTOR's expense, an independent laboratory analysis to determine if the material meets specification requirements.
3. The CONTRACTOR shall be present during testing.
4. ICCP:
   a. When construction is complete, notify the ENGINEER in writing a minimum of 3 days prior to when the installation is ready to be turned on.
   b. Testing shall be performed by the CONTRACTOR's Senior Corrosion Technologist or representative.
   c. Notify the ENGINEER in writing a minimum of 2 days prior to testing.
   d. Energize installation.
   e. Conduct an operating test to demonstrate that equipment and material are installed correctly and operating properly for initial approval by the ENGINEER.
   f. Functional testing:
      1) Demonstrate operation of the rectifier from 0% to 100% of the rated capacity.
      2) Test across terminal and junction box shunts to confirm all portions of groundbed are functioning correctly.
      3) Test the system resistance.
      4) Test the resistance of the earth of the deep anode system.
      5) Test the resistance to earth of the structure.
      6) Test the current output of each anode.
      7) Test the resistance between anodes.
   g. Final testing/commissioning: Make adjustments in the output of the system and conduct sufficient testing throughout the network of protected structures and piping to ensure proper installation.
   h. Locate, correct, and retest system defects or incomplete Work identified during functional and final testing/commissioning or warranty inspections at no additional cost to the OWNER.

END OF SECTION

SECTION 13 47 15
GALVANIC CATHODIC PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for galvanic cathodic protection.

B. Related Sections:

1. SECTION 13 47 13 – COMMON WORK RESULTS FOR CATHODIC PROTECTION
2. SECTION 13 47 17 – COMMISSIONING AND TESTING OF CATHODIC PROTECTION SYSTEMS
3. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS

1.2 REFERENCES

A. ASTM International (ASTM):

1. B 418 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes
2. B 843 – Standard Specification for Magnesium Alloy Anodes for Cathodic Protection

1.3 SUBMITTALS

A. As specified in SECTION 13 47 13.

B. Quality Control Submittals:

1. As-Built Drawings of anodes showing the exact locations of wiring, connections, and terminal boxes.
2. Senior Corrosion Technologist qualifications: As specified in SECTION 13 47 13.
3. Testing data: As specified in SECTION 13 47 17.

C. Warranty Documentation:

1. Sample warranty.
2. Warranty.

D. The following checklist can be found online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual.

1. Contractor Corrosion Prevention Project Progress Checklist.

1.4 QUALITY ASSURANCE

A. Senior Corrosion Technologist: As specified in SECTION 13 47 13.

B. Provide the Manufacturer's certification that anode components meet the requirements of the Contract Documents, include references for the applicable Sections and Standard Details.

C. Anode Locations:

1. Locations shown on the Drawings are approximate.
2. Determine the exact location by field conditions, non-interference with other utilities, or mechanical and structural features.
3. Note existing utilities in the area and avoid damage to them.
4. Repair damages to utilities to the satisfaction of the ENGINEER and other utility representatives at the CONTRACTOR's expense.

D. Materials, fabrication, and installation are subject to inspection and testing by the ENGINEER.

1.5 WARRANTY

A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the passive CP for buried and submerged piping, structures, and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Magnesium Anodes:

1. Farwest Corrosion Control, Ultramag High Potential
2. Mesa, High Potential
3. Galvotec, High Potential

B. Magnesium Condenser Anodes:

1. Farwest Corrosion Control
2. Mesa
3. Galvotec

C. Zinc Anodes:

1. Farwest Corrosion Control
2. Mesa

D. Welding Rods:

1. Fleetweld P-5E6010 or P-5plus E6010

2.2 MATERIALS

A. Magnesium Anodes:

1. Standard high potential ingots, prepackaged in permeable cloth bags with a backfill composition of 75% hydrated gypsum, 20% powered bentonite, and 5% anhydrous sodium sulfate completely surrounding the ingot.
2. Metallurgic composition of the magnesium ingots shall be in accordance with ASTM B 843, Grade M1C as follows:

Element	Composition
Aluminum	0.01% maximum
Manganese	0.50% to 1.3%
Copper	0.02% maximum
Silicon	0.05% maximum
Nickel	0.001% maximum

Element	Composition
Iron	0.03% maximum
Other (each)	0.05% maximum
Magnesium	Remainder

3. Bare magnesium ingot, backfill, and total weights shall conform to:

Ingot Weight (lbs)	Backfill Weight (lbs)	Total Weight (lbs)
2.5 (condenser)	--	--
9	18	27
7	28	35
20	50	70
32	38	70
48	52	100

4. Anode steel core: Cast with a galvanized steel recess at one end for the lead conductor connection.
5. Anode lead conductor:
   a. #12 AWG stranded copper conductor with RHH/RHW insulation as specified in SECTION 26 05 19.
   b. Connect to core with silver solder.
   c. Insulate connection by filling the remainder of the recess with electrical potting compound.
   d. Length shall be sufficient to extend from the anode to the designated termination point without a splice.
   e. Replace conductors with cut or damaged insulation at the CONTRACTOR's expense.
   f. Conductors shall be long enough to reach to the test station terminal box or to the pipeline or structure for attachment using the exothermic weld method, as specified in SECTION 13 47 13, without a splice.

B. Magnesium Condenser Anodes:
1. Bare standard potential round magnesium ingots cast around 3/4-inch steel pipe core with 1/2 inch diameter – 13NC by 1 inch deep drilled and tapped center hole.
2. Diameter, 5 inches; 2 inch thickness.
3. Weight: 2.5 lbs.
4. Anodes with any coating such as plastisol are not acceptable.
5. Metallurgic composition of the magnesium ingots shall be in accordance with ASTM B 843, Grade AZ63B as follows:

Element	Composition
Aluminum	5.3% to 6.7%
Zinc	2.5% to 3.5%
Manganese	0.15% minimum
Silicon	0.10% maximum
Copper	0.02% maximum
Nickel	0.002% maximum
Iron	0.003% maximum
Other	0.30% maximum
Magnesium	Remainder

C. Zinc Anodes:
1. High purity zinc ingots prepackaged in permeable cloth bags with backfill composition of 75% hydrated gypsum, 20% powered bentonite, and 5% anhydrous sodium sulfate completely surrounding the ingot.
2. Metallurgic composition of zinc ingots shall be in accordance with ASTM B 418, Type II as listed herein:

Element	Composition
Aluminum	0.1% to 0.5%
Cadmium	0.025% to 0.07%
Copper	0.005% maximum
Iron	0.005% maximum
Lead	0.006% maximum
Zinc	Remainder

3. Bare zinc ingots, backfill, and total weights shall conform to:

Ingot Weight (lbs)	Backfill Weight (lbs)	Total Weight (lbs)
5	11	16
15	35	50
33	67	100
45-48	52-55	100

4. Anode steel core: Full length galvanized 1/4 inch diameter steel core, exposed at one end for connection to the lead conductor.
5. Anode lead conductor: As specified in this Section.

PART 3 EXECUTION

3.1 INSTALLATION

A. Prepackaged Magnesium Anodes and Zinc Anodes:
1. Remove plastic or paper shipping wrap from the anode prior to placement.
2. Install horizontally or vertically at the bottom of the hole or trench:
a. Place anode at a depth between springline and the bottom of pipe and a minimum of 5 feet away from the pipeline or the structure.
b. Lower each anode into the hole or trench using a rope or sling. Do not lower, transport, handle, or lift the anode by the lead conductor.
c. Take care to ensure the cloth bag is not damaged and that no backfill is lost during installation.
3. Provide backfill of native soil around installed anodes. ENGINEER approval is required for imported backfill.
4. Prior to connecting the anode to the pipe, record native pipe-to-soil potential.
5. If anodes are installed in the pipe trench, evenly distribute anodes on alternate sides of the pipe. If installing through a keyhole, ensure a minimum of 10 feet of clearance from the anode to the edge of the pipe.
6. For installations with multiple anodes, provide a minimum of 12 inches of clearance between anodes.

B. Magnesium Condenser Anodes:
1. Anode attachment:
a. Use a standard threaded 2 1/2 inch by 1/2-inch steel bolt or stud welded to the metallic surface.
b. Ensure surfaces are clean and dry.
c. Use a grinding wheel to remove coating, mill scale, oxide, grease, and dirt from a 2 inch by 2 inch area.
d. Obtain approval for the chemicals for use in surface preparation.
e. Grind the surface to bright metal.
f. Weld the bolt or stud to the surface using a welding rod; make sure the entire base of the bolt or stud is welded.
g. After welding is complete, remove slag with a slag hammer.
h. Tap on the bolt or stud with a rubber mallet to ensure the weld is stable and secure.
i. Screw the anode to the bolt or stud by turning the anode in a clockwise direction.

C. GPS Locations: As specified in SECTION 13 47 13.

D. Post Installation Backfilling of Anode – Lead Conductors: Replace anode lead conductors that are damaged during backfill or that have a high resistance connection to substrate.

3.2 QUALITY CONTROL

A. Intermittent and Final Testing: As specified in SECTION 13 47 17.

END OF WORK

INTENTIONALLY BLANK

SECTION 13 47 16
ISOLATION AND BONDING FOR CATHODIC PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for isolation and bonding for cathodic protection.

B. Related Sections:

1. SECTION 09 97 13.04 – WAX TAPE COATINGS
2. SECTION 13 47 13 – COMMON WORK RESULTS FOR CATHODIC PROTECTION
3. SECTION 13 47 17 – COMMISSIONING AND TESTING OF CATHODIC PROTECTION SYSTEMS
4. SECTION 22 00 00 – PLUMBING
5. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
6. SECTION 33 14 11 – WATER UTILITY TRANSMISSION AND DISTRIBUTION PIPING – GENERAL

1.2 REFERENCES

A. American Water Works Association (AWWA):

1. C 219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe

B. ASTM International (ASTM):

1. D 1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
2. F 436 – Standard Specification for Hardened Steel Washers

C. NACE International (NACE):

1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
2. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

1.3 SUBMITTALS

A. As specified in SECTION 13 47 13.

B. Quality Control Submittals:

1. Senior Corrosion Technologist qualifications: As specified in SECTION 13 47 13.

C. Warranty Documentation:

1. Sample warranty.
2. Warranty.

D. Testing Data: As specified in SECTION 13 47 17.

E. The following checklist can be found online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/capital-projects-procedures-manual.

1. Contractor Corrosion Prevention Project Progress Checklist.

1.4 QUALITY ASSURANCE

A. Senior Corrosion Technologist: As specified in SECTION 13 47 13.

B. Provide the Manufacturer's certification that materials components meet the requirements of the Contract Documents; include references for the applicable Sections and standard details.

C. Provide the Manufacturer's stamp on materials components.

D. Materials, fabrication, and installation are subject to inspection and testing by the ENGINEER.

1.5 WARRANTY

A. Warranty for 1 year from the Substantial Completion date for the satisfactory performance and installation of the flange electrical isolation and joint continuity bonding for cathodically protected metallic piping systems and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Insulating Flange Gasket:

1. Durlon 8600
2. Garlock 3200
3. KlingerSil C-4324
4. KlingerSil C-6400
5. Leader 940
6. Lamon's L441

B. BSTC:

1. As specified in SECTION 33 14 11

C. Valve Stem Insulation:

1. Lovejoy Spider

D. Hardware Protection Caps:

1. Advance Products and Systems, Inc., Radolid Protection Caps

E. Insulating Dielectric Unions and Couplings:

1. Watts LF3003:
   a. Hart Industrial Unions

2.2 MATERIALS

A. Provide Flange Isolation Sets:

1. As specified in SECTION 33 14 11.
2. Provide where shown on the Drawings.

3. Include slip-on insulating gasket, insulating sleeves, insulating washers or combination sleeve and washers, and steel washers.
4. Insulating flange gasket:
   a. Non-asbestos, full face, 1/8 inch thick and unsegmented.
   b. Aramid fiber with SBR binder.
   c. Weld-neck insulating gaskets shall not be used without the ENGINEER's approval.
5. Insulating sleeves and washers for stud diameters 1 1/2 inches or smaller:
   a. Two-piece, 1/32 inch thick.
   b. Material: G10.
   c. Insulating washer: Diamond-Hyde or G10.
   d. Sleeve lengths: One flange thickness plus one gasket thickness.
   e. Flange bolt holes: 1/4 inch oversized.
6. Insulating sleeves and washers for stud diameters larger than 1 1/2 inches:
   a. Two-piece, 1/32 inch thick.
   b. Material: G10.
   c. Insulating washer: Diamond-Hyde or G10.
   d. Sleeve lengths: One flange thickness plus two gasket thicknesses.
   e. Flange bolt holes: 1/4 inch oversized.
7. Steel washers: Hardened steel in accordance with ASTM F 436.
8. Thread Lubricant: Non-conductive, non-metallic based lubricant.

B. BSTC: Manufactured in accordance with AWWA C 219 and as specified in SECTION 33 14 11.

C. Valve Stem Insulation:
1. Finger coupler.
2. Material: SOX, NBR, Rubber, Nitrile Butadlene, Buna-N Rubber.

D. Joint Continuity Bonding:
1. As specified in SECTION 26 05 19.
2. Provide #2 AWG, #4 AWG, or #8 AWG conductors on push-on, mechanical, or uninsulated flanged joints; welded steel pipe does not require bond conductor.
3. Type: AWG solid or stranded copper conductor rated at 600 V, HMWPE insulation suitable for direct burial in corrosive soil or water in accordance with ASTM D 1248, Type 1, Class C.
4. Conductor size and number of conductors required:

Pipe Size (Inches)	Conductor Size (AWG)	No. of Conductors per Joint
12 and smaller	#8	2
14 to 36	#4	2
40 and larger	#2	3

5. Conductor insulation: As determined by the ENGINEER and shown on the Drawings in the conduit and conductor schedule.
6. Length: Sufficient to accommodate pipe or joint movement without damage to conductor or exothermic weld; 1 inch minimum slack on each side or 2 inches total.
7. Provide with formed copper sleeves at each end of the conductor.
8. The wire conductor for field-applied sleeves shall extend a 1/4 inch beyond the end of the copper sleeve.
9. Angle the end of factory-formed sleeves to allow the end of the conductor to be exposed to the exothermic weld material.

E. Hardware Protection Caps:
1. Type: Low-density PE for nuts or bolts with washers.
2. Color: Black

F. Insulating Dielectric Unions and Couplings on Outlets: Install on all outlet connections including but not limited to process and instrumentation piping, drains, corporation stops, air valves, and pressure sensing assemblies. Insulating couplings or fittings that only electrically isolate the interior of the pipe are not acceptable. Approved Manufacturers shall be as specified in SECTION 22 00 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Insulated Flange Gasket Sets:
1. Install as shown on the Drawings, in accordance with the Manufacturer's instructions, and in accordance with NACE SP0286.
2. Clean flange surfaces and holes of dirt, grease, oil, and contamination.
3. Examine flange and bolt hole surfaces for burrs, sharp edges, or spurs.
4. Remove irregularities.
5. Align flanges concentric and parallel.
6. Line up bolt holes with non-tapering drift pins at a minimum of three locations with 120 degrees of separation to prevent damage to insulating sleeves.
7. Protect the gasket from damage.

8. Do not use grease, lubricant, or adhesives on flange faces or on the gasket.
9. Measure and adjust the sleeve length as specified in this Section.
10. Insert sleeves over studs and place a metal washer over the end. Line up holes in the flange and install a stud with the sleeve into place.
11. Do not force the stud insulating sleeve into the flange.
12. Check alignment and readjust as required.
13. If damaged, replace the insulating sleeve.
14. Place a metal washer on the end of the insulating sleeve and secure it with a nut.
15. Tighten studs a few turns at a time, in sequence, and use the sequence in accordance with the Contract Documents until the studs are uniformly tightened and both flanges are in uniform contact with the gasket.
16. Repeat the tightening sequence with a torque wrench at the Manufacturer's recommended torque value.
17. Install the bond station as shown on the Drawings as specified in SECTION 13 47 13.
18. Test the flange to ensure the insulator is functioning properly prior to backfilling.
19. The Senior Corrosion Technologist shall test the joint to assure proper functionality of the insulator and the bond site as specified in SECTION 13 47 17.
20. Contact the ENGINEER a minimum of 2 days prior to testing.
21. The ENGINEER may observe or assist with testing. Allow the ENGINEER adequate time to inspect insulating flanges prior to backfill.
22. For failed insulated flanged joints:
    a. Disassemble joint.
    b. Replace malfunctioning insulation materials.
    c. Reassemble joint using new studs.
    d. Retest joint as specified in this Section.
    e. Contact the ENGINEER as specified in this Section.
23. Install wax tape on flanges and bolts as specified in SECTION 09 97 13.04.
24. Do not install pipe stands or other appurtenance items across insulating flange sets.

B. BSTC:
1. Install in accordance with NACE SP0286 and as specified in SECTION 33 14 11.
2. Coat with wax tape as specified in SECTION 09 97 13.04.

C. Valve Stem Insulation: Install in accordance with the Manufacturer's recommendations.

D. Joint Continuity Bonding:
1. Bond non-insulated, push-on, and flexible coupled joints to provide electrical continuity across joints. Bonding conductors shall be as follows:

Nominal Pipe Diameter	Wire Size (AWG)
4 inch to 12 inch	#8 HMWPE
16 inch to 20 inch	#4 HMWPE
24 inch ≤ 36 inch	#4 HMWPE
36 inch ≤ 60 inch	#2 HMWPE
60 inch or larger	2x #2 HMWPE

2. Electrical bonding shall be in accordance with NACE SP0169.
3. The size and number of conductors needed per joint shall be in accordance with this Section.
4. Prepare metallic surfaces and attach electrical bonding conductors to metallic surfaces with exothermic welds as specified in SECTION 13 47 13.
5. Repair coating and lining damage.
6. Push-on joints:
    a. Cut the conductor to proper length.
    b. Strip 1 inch of insulation from each end of the conductor.
    c. Attach copper sleeves to the bare ends of the conductor.
    d. Exothermic weld one end of the conductor to the bell of the joint and the other end of the conductor to the spigot of the joint.
    e. Visually and physically test the quality of connections by tapping with a hammer and lightly pulling on the conductor.
    f. Remove and replace visually defective, porous, or inadequate exothermic welds.
7. Flanged joints:
    a. Cut the conductor to the proper length.
    b. Strip 1 inch of insulation from each end of the conductor.
    c. Attach copper sleeves to the bare ends of the conductor.
    d. Exothermic weld one end of the wire to one flange and the other end of the conductor to the opposite flange.
    e. Test the conductors as described herein.
8. BSTC:
    a. Cut the conductor to the proper length.
    b. Strip 1 inch of insulation from each end of the conductor.
    c. Attach copper sleeves to the bare ends of the conductor.

d. Exothermic weld one end of Conductor 1 to the pipe and the other end of Conductor 1 to the barrel of the coupling.
e. Exothermic weld one end of Conductor 2 to the barrel of the coupling and the other end of Conductor 2 to the opposite side of the pipe.
f. Exothermic weld one end of Conductor 3 to the pipe and the other end of Conductor 3 to one follower ring.
g. Exothermic weld one end of Conductor 4 to the opposite follower ring and the other end of Conductor 4 to the corresponding side of the pipe.
h. Test the conductors as described herein.
i. For insulated coupling, omit steps e and g.

E. Backfilling – Bond Conductors:
1. Protect joint continuity bond conductors to prevent damage to the conductor or the insulation during backfilling.
2. Perform continuity testing by means of a pipe locator at intervals determined by the ENGINEER prior to the Final Completion date. Record test results.
3. Replace joint continuity bond conductors found to be damaged or to have a high resistance connection at no additional expense to the OWNER.
4. GPS locations: As specified in SECTION 13 47 13.

F. Hardware Protection Caps: Install in accordance with the Manufacturer's recommendations.
G. Do not install pipe stands or other appurtenances across insulating flanges or couplings.

3.2 QUALITY CONTROL
A. Intermittent and Final Testing: As specified in SECTION 13 47 17.
B. Test insulating flanges and couplings immediately prior to backfill, and immediately following backfill.

END OF SECTION

SECTION 13 47 17
COMMISSIONING AND TESTING FOR CATHODIC PROTECTION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for commissioning and testing for cathodic protection systems.

B. Related Sections:

1. SECTION 13 47 13 – COMMON WORK RESULTS FOR CATHODIC PROTECTION
2. SECTION 13 47 16 – ISOLATION AND BONDING FOR CATHODIC PROTECTION

1.2 REFERENCES

A. American National Standards Institute/International Electrical Testing Association (ANSI/NETA):

1. ATS – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

B. NACE International (NACE):

1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
2. SP0177 – Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
3. SP0286 – Electrical Isolation of Cathodically Protected Pipelines
4. SP0572 – Design, Installation, Operation, and Maintenance of Impressed Current Deep Anode Beds
5. TM0113 – Evaluating the Accuracy of Field-Grade Reference Electrodes
6. TM0497 – Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

1.3 DEFINITIONS

A. Startup: Includes putting the complete facility or system in operating order, cleaning, adjusting and balancing equipment, initial operation of equipment item, operating equipment, starting systems, operation of systems, testing of equipment and systems, and demonstration and verification of the completed facility and/or system as a unit.

B. Functional Test: A test or tests in the presence of the ENGINEER to demonstrate that the equipment or system meets the OWNER's installation and adjustment requirements.

C. Performance Test: A test performed in the presence of the ENGINEER and after any required functional test specified, to demonstrate and confirm that the equipment and/or system meets the specified performance requirements.

D. Commissioning: The commissioning period begins when the facility or the system has been successfully started up and has met the Substantial Completion requirements.

E. Significant Interruption: May include any of the following events:

1. Failure of the CONTRACTOR to maintain qualified on-site startup personnel as scheduled.
2. Failure to meet the specified performance for more than 4 consecutive hours.
3. Failure of any equipment unit, system, or subsystem that is not satisfactorily corrected within the same day.
4. As may be determined by the ENGINEER.

F. Startup Test Period: Startup of the entire facility or system or any portion thereof includes coordinated operation of the facilities by the CONTRACTOR, the Subcontractors, the ENGINEER’s operating personnel, and the Manufacturer's Representatives for equipment items and systems after the required functional tests have been completed and those performance tests deemed necessary for the safe operation of the entire facility have been completed.

G. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment.

H. CSE: Copper Sulfate Electrode.

1.4 SUBMITTALS

A. As specified in SECTION 13 47 13.

B. Shop Drawings and Administrative Submittals:

1. Shall be approved prior to performing commissioning and testing.
2. Testing technician resume(s) and NACE certification documentation.
3. Schedule for performing inspection and tests.
4. List of references and the procedure to be used for each test.
5. Equipment description, model number, and calibration information for each testing device.
6. A sample copy of the individual system test report form. Test report forms for functional testing and performance testing in a format acceptable to the ENGINEER and certification of the functional test for each piece of equipment or system specified.
7. The startup and commissioning manual shall include as a minimum:
   a. Schedule including time durations for each test, test plan, procedures, and log format.
   b. A listing of the sequential steps shall be observed to demonstrate that the equipment as a whole functions as intended.

C. Quality Control Submittals:

1. Certified test and inspection reports. Photographs for each item tested submitted prior to the Substantial Completion date.
2. Hardcopy and electronic version of installed programs, settings, complete model numbers, equipment and material characteristics.
3. O&M data:
   a. Provide a complete final commissioning manual and provide individual testing reports in each applicable O&M manual.

b. A final approved, certified test, inspection, and startup reports.

1.5 QUALITY ASSURANCE

A. Senior Corrosion Technologist: Commissioning and testing surveys are performed under the direction of a NACE certified Senior Corrosion Technologist.

B. Testing Firm Qualifications:
1. A corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of Manufacturers, Suppliers, and installers of CP products/systems being tested.
a. The CP Subcontractor may install, test, and commission impressed current CP systems with written ENGINEER approval.
3. An employer of engineers and technicians regularly engaged in testing and inspecting of CP equipment, installations, and systems.
4. A supervising engineer accredited as a certified NACE corrosion technologist and having a minimum of 5 years of testing experience on similar projects.
5. Technicians certified by NACE.
6. Comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions prepared, stamped and signed by a Professional Engineer registered in the State of Colorado.

C. Tester Qualifications:
1. The technician performing CP tests shall be a NACE qualified CP Tester (CP 1), minimum.
2. Testing and startup shall be overseen by a NACE qualified CP Specialist (CP 4) or Senior Corrosion Technologist.

D. Test equipment shall have an operating accuracy equal to, or greater than, the requirements established by ANSI/NETA ATS.
1. Store testing equipment in accordance with the Manufacturer's recommendations.
2. Perform tests using the Manufacturer's certified calibrated testing equipment.

E. Test instrument calibration shall be in accordance with ANSI/NETA ATS.

F. CONTRACTOR Facility Startup Responsibilities:
1. Perform Work for the tests specified, including existing equipment.
2. Demonstrate proper installation, adjustment, function, performance, and operation of equipment.
a. Immediately notify the ENGINEER of CP system performance defects that may be a result of installation errors. Provide further testing and reporting as needed to determine the cause of any system defects that may be related to installation work.

G. OWNER/ENGINEER Facility Startup Responsibilities:
1. General:
a. Review the CONTRACTOR's test plan and schedule.
b. Witness each functional or performance test.
c. Coordinate other OWNER operations, if necessary, to facilitate the CONTRACTOR's tests.
d. Provide items as required for testing. When available, these may include power, water, or other utilities.
2. Startup test period: Operate process units and devices, with the support of the CONTRACTOR.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Multi-Meter:
1. Fluke

B. CSE:
1. GMC Portable Reference Electrode
2. M. C. Miller, RE-Series
3. Tinker and Rasor, Models 3A, 6A, 6B, 8A, 8B

C. Above Ground Radio Frequency Insulator Tester:
1. M. C. Miller Model 601
2. Tinker & Rasor Model RF-IT

2.2 MATERIALS

A. Multi-Meter: Minimum 10 mega-ohm impedance.

B. CSE:
1. Minimum 1-inch plug diameter.
2. Measured potential within 15 mV of calibrated CSE in accordance with NACE TM0113. Calibrate reference electrode within 1 day of testing.
3. Stability within 10 mV with 3.0 microamp load.

PART 3 EXECUTION

3.1 GENERAL

A. Tests and inspection shall establish:
1. CP.
2. Electrically insulated coatings.
3. Flange and bolted sleeve type coupling electrical isolation:
a. Insulating flange gasket.
b. Insulating sleeves and washers.
c. Bolted sleeve type coupling.
4. Control of stray current.
5. Connection of test stations.

B. Verify that nameplate data and conductor connections are in accordance with the Contract Documents. Where any deviations are found, provide written documentation of findings to the ENGINEER.
C. Tighten connections, including wiring connections, to the Manufacturer's recommendations.
D. Clean contaminated surfaces with cleaning solvents to the Manufacturer's recommendations.
E. Pipe and test lead conductors shall be clean, dry, and free of foreign materials.
F. Vacuum and wipe clean enclosure interior.
G. Remove corrosion found on metal surfaces.
H. Replace missing or damaged hardware.
I. Finish: Provide matching paint and touch up scratches and mars.
J. Conductors:
    1. Inspect each individual exposed power cable for physical damage.
    2. Proper connections shall be in accordance with the Contract Documents.
    3. Cable bends not in accordance with the Manufacturer's minimum allowable bending radius where applicable.
    4. Color coding in accordance with the Contract Documents.
    5. Continuity test by ohmmeter method to ensure proper cable connections.
    6. Insulation resistance test for conductors being reused:
        a. Test existing conductors that are to be reused with new equipment conductors spliced to existing conductors.
        b. Utilize 1,000 VDC mega-ohm meter for 600 V insulated conductors.
        c. Test each conductor with respect to ground and to adjacent conductors in accordance with ANSI/NETA ATS procedures for 1 minute.
        d. Evaluate ohmic values by comparison with conductors of the same length and type.
        e. Document and report the values.
        f. Report values less than 50 mega-ohms to the ENGINEER before proceeding with reuse.
K. Instrumentation and Measurement Guidelines:
    1. CP electrical measurements require the proper selection and use of instruments. Pipe-to-electrolyte potential, voltage drop, potential difference, and similar measurements require instruments that have appropriate voltage ranges. The user shall know the capabilities and limitations of the equipment, follow the Manufacturer's instruction manual, and be skilled in the use of electrical instruments. Failure to select and use instruments correctly causes errors in CP measurements.
    2. Analog instruments are specified in terms of input resistance or internal resistance. This is expressed as ohms per V of full meter scale deflection.
    3. Digital instruments are specified in terms of input impedance expressed as mega-ohms.
    4. To measure pipe-to-electrolyte potentials accurately, a digital voltmeter shall have a high input impedance, high internal resistance, for an analog instrument compared with the total resistance of the measurement circuit.
    5. A pipe-to-electrolyte potential is measured using a DC voltmeter having an appropriate input impedance (or internal resistance, for an analog instrument), voltage range(s), test leads, and a stable CSE.
    6. Testing equipment includes:
        a. Voltmeter.
        b. Test leads.
        c. CSE.
        d. Above ground radio frequency insulator tester.

3.2 QUALITY CONTROL
A. Functional Testing:
    1. Begin testing at a time mutually agreed upon by the ENGINEER, the Manufacturer's Representative(s), and the CONTRACTOR.
    2. Notify the ENGINEER and the Manufacturer's Representative in writing at least 14 days prior to the scheduled date of functional tests.
    3. If, in the ENGINEER's opinion, each system meets the functional requirements specified, such system will be accepted as conforming for purposes of advancing to performance testing phase, if required.
    4. If, in the ENGINEER's opinion, functional test results do not meet the requirements specified, the systems will be considered as nonconforming.

3.3 STARTUP:
A. Rectifiers/Impressed Current CP Systems:
    1. Installation shall be in accordance with NACE SP0572.
    2. Provide system settings and information including, but not limited to:
        a. Transformer rectifier location/station and voltage.
        b. Manufacturer, maximum voltage output, maximum current output, and phase.
        c. Individual anode current outputs.
        d. Well resistance at 5 foot intervals for the length of the active column.
        e. Groundbed resistance to earth.
        f. Structure/pipeline resistance to earth.
        g. Resistance between individual anodes.
    3. Passive (galvanic) CP systems:
        a. New CP system installations:
            1) New CP systems' testing shall be in accordance with NACE TM0497.

2) Before the test, verify that CP equipment has been installed and is operating properly. Time shall be allowed for the pipeline potentials to reach polarized values.
3) Make electrical contact between the reference electrode and the electrolyte (soil) at the test station, directly over the centerline of the pipeline or as close to it as is practicable.
4) Connect the voltmeter to the pipeline and CSE. Record the pipe-to-electrolyte potential and its polarity with respect to the CSE.
5) CP shall be judged adequate at the test station if:
a) The pipe-to-soil potential measurement is negative 850 mV or more negative, with respect to the CSE.
b) There is a 100 mV, or more, negative shift from native, CP off, potential.

b. CP improvements (existing pipe, anode bank installations):
1) Test and record the anode conductor with respect to BRE and handheld CSE. Record values for both native and polarized condition.
2) Measure current output of each anode using the test station shunt and record values.
3) Test and record the pipe conductor with respect to BRE and CSE.
4) Test and record values at the nearest test stations on either side.
5) Terminate conductors.
6) Test and record the connected conductors with respect to the BRE and the CSE.
7) Test and record values at the nearest test stations on either side. Measure post connection influence.
8) Disconnect conductors.
9) When the installations are complete, connect anodes at each test station as specified by the ENGINEER:
a) Test and record values at the test stations.
b) Retest in 1 week, after polarization has occurred; record values.
(1) If acceptable criteria is not achieved, contact the ENGINEER.

B. Electrical Isolation and Joint Continuity Bonding:
1. As specified in SECTION 13 47 16 and in accordance with NACE SP0286.
2. Underground insulator testers are not acceptable for conformance testing.
3. Test electrically isolated flanges and couplings using above ground radio frequency tester. Retest flanges and couplings for electrical isolation following any work on the flange, sleeves, bolts, or nuts. Immediately notify the ENGINEER if electrically isolated flanges or couplings fail tests.
a. Indicate the magnitude of any shorts or continuity detected during testing. If the measured failure is partial, test each bolt individually to identify bolt sleeve failures. Refer to the Manufacturer's recommendations for test procedure.

C. Demonstration and Calibration of CP System:
1. General: Demonstrate that piping and structures included in CP design are in accordance with NACE SP0169.
a. Provide verification that stray AC current does not exist on the pipeline. If found, provide measured AC voltage and mitigation plan in accordance with NACE SP0177.
2. Calibration:
a. Passive (galvanic) CP systems:
1) Connect anodes and coupons in the test station terminal board as required to increase CP to pipeline or structure and provide acceptable structure-to-earth potentials.
a) Unless otherwise shown on the Drawings, terminate anodes so that they are continuous with pipe conductors. If there is more than one pipe conductor in the test station, distribute anodes evenly among pipe conductors so that the measured pipe-to-soil potentials are in accordance with NACE SP0169.
b) Do not connect anodes to pipe conductors that are suspected or confirmed to be continuous with electrical ground.
2) Provide documentation detailing terminal board connections.
3) Test the structure or the pipeline at points farthest away from CP anodes. Ensure adequate polarization is achieved.
4) Record the current output of each anode using the test station shunt.
5) Provide interrupted measurement of pipe-to-soil potential at each test station. Connect anodes for a minimum of 24 hours prior to interrupting current to determine the polarized potential of the structure.
b. Rectifiers/impressed current CP systems:
1) Adjust the rectifier output so that the intended piping and structures are in accordance with NACE SP0169. Set the rectifier at the lowest possible current output to achieve protection.
2) Verify electrical continuity for Work done on pipe or appurtenances with impressed current CP systems. Install bond wires as needed to ensure electrical continuity is maintained for pipelines with impressed current CP.
3) Synchronize current interruption for rectifiers that may affect the cathodic protection circuit being tested.
4) Measure interrupted pipe-to-soil potentials at test stations affected by the impressed current CP system at a minimum of three output levels and document the polarized potential of pipe.

D. Documentation:
1. Provide daily reports of testing procedures and results.
2. Fabrication and installation details of test stations.
3. Provide diagrams/sketches or photographs of terminal board arrangement.

4. Immediately report any problems or failures to the ENGINEER.

E. Commissioning of the entire facility will be considered complete when:
   1. Successful CP system is completed and documented.
   2. Reports are submitted and approved.
   3. Test stations are labeled and conductors are terminated and correctly identified with marking sleeves.
   4. Site restoration is complete.

END OF SECTION

INTENTIONALLY BLANK

SECTION 22 00 00
PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for plumbing.

B. Related Sections:

1. SECTION 09 90 00 – PAINTING AND COATING
2. SECTION 13 47 16 – ISOLATION AND BONDING FOR CATHODIC PROTECTION
3. SECTION 33 05 24.23 – STEEL PIPE FOR WATER TRANSMISSION
4. SECTION 33 14 17 – WATER SERVICE LINES
5. SECTION 33 14 19 – VALVES FOR WATER UTILITY PIPING

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. B1.1 – Unified Inch Screw Threads, (UN And UNR Thread Form)
2. B1.20.1 – Pipe Threads, General Purpose, Inch
3. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
4. B16.11 – Forged Fittings, Socket-Welding and Threaded
5. B16.22 – Wrought Copper & Copper Alloy Solder-Joint Pressure Fittings
6. B16.24 – Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, & 2500
7. B40.200 – Thermometers, Direct Reading And Remote Reading

B. American Water Works Association (AWWA):

1. C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
2. C509 – Resilient-Seated Gate Valves for Water Supply Service
3. C515 – Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
4. C550 – Protective Interior Coatings for Valves and Hydrants
5. C651 – Disinfecting Water Mains
6. C800 – Underground Service Line Valves and Fittings

C. ASTM International (ASTM):

1. A 53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. A 182 – Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
4. A 194 – Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
5. A 276 – Standard Specification for Stainless Steel Bars and Shapes
6. A 312 – Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
7. A 320 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
8. A 774 – Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
9. A 778 – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
10. B 32 – Standard Specification for Solder Metal
11. B 75 – Standard Specification for Seamless Copper Tube
12. B 88 – Standard Specification for Seamless Copper Water Tube
13. B 584 – Standard Specification for Copper Alloy Sand Castings for General Applications
14. D 1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
15. D 2467 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
16. D 2564 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
17. E 77 – Standard Test Method for Inspection and Verification of Thermometers
18. F 656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D. Manufacturers Standardization Society (MSS):

1. SP-43 – Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications
2. SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture, Selection, Application, and Installation
3. SP-69 – Pipe Hangers and Supports – Selection and Application

E. NSF International (NSF):

1. 60 – Drinking Water Treated Chemicals

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer.
2. Material.
3. Equipment drawings and data.
4. Valve actuator power and control wiring diagrams, including terminals and numbers.
5. Complete motor nameplate data.
6. Open/close and throttling valve actuators sizing calculations.
7. Maximum torque capabilities of the valve operator mechanism and the operating torque requirement for each valve under the specified operation condition.

8. Color and finish.

B. Shop Drawings:
1. Drawings showing changes in the location of fixtures or equipment that are advisable in the opinion of the CONTRACTOR.
2. Changes in the location of equipment or piping that affects connecting or adjacent Work, before proceeding with Work.
3. Drawings of the piping support system that locate each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
4. Revisions to support systems resulting from changes in the related piping system layout or the addition of flexible joints.

C. Test records produced during testing.

D. Leakage Test Plan: Submit prior to testing and include at least the following:
1. Testing dates.
2. Piping systems and sections to be tested.
3. Test type.
4. Method of isolation.
5. A calculation of the maximum allowable leakage for the sections to be tested.
6. Certifications of calibration: Testing equipment.
7. A certified test report following testing.

1.4 QUALITY ASSURANCE

A. Design Requirements:
1. Design, size, and locate piping support systems throughout the facility, whether or not shown on the Drawings.
2. Piping, smaller than 30 inches: Pipe supports are shown on the Drawings only where specific types and locations are required; provide additional supports as required.
3. Piping, 30 inches and larger: Support systems are designed for the piping shown on the Drawings.
4. In accordance with MSS SP-58 and MSS SP-69.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Insulating Dielectric Unions and Flanges:
1. Capitol Insulation Unions
2. Epco Sales, Inc.
3. Watts
4. Hart Industrial Unions

B. Channel Type Support Systems:
1. Cooper B-Line, Traditional Strut System
2. Unistrut, Series P3200

C. Sleeve-seal Systems:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

D. Pipe Sleeve Modular Mechanical Seal:
1. Thunderline Link-Seal

E. Hose Valves and Hydrants – HB-1, Hose Valve:
1. Jenkins, Figure 106-BJ

F. Gate Valves:
1. Type V125 resilient-seated gate valve:
a. American AVK (C509 and C515)
b. American Flow Control (C515 only)
c. Clow (C509 and C515)
d. EJ (C515 only)
e. Kennedy (C509 and C515)
f. Mueller (C509 and C515)
g. United States Pipe and Foundry Company (C509 and C515)

G. Ball Valves:
1. Type V300 ball valve: Apollo, 82 series
2. Type V301 ball valve: Dezurik, FPB
3. Type V302 ball valve: Apollo 80 series
4. Type V464 corporation stop: Ford Meter Box Co.

H. Globe Valves:
1. Type V200 globe valve:
a. Crane Co., 7TF, threaded end
b. Stockham, B-22T, threaded end
c. Stockham, B-24, soldered end

I. Check Valves:
   1. Type V605 check valve:
      a. Milwaukee
      b. Stockham
J. Buried Operator:
   1. EIM WB Series
   2. Limitorque HBC
K. Pressure Gauge:
   1. Ashcroft, Model 1009SW
L. Gauge Cock Valves:
   1. Ernst Gage Co.
   2. Lunkenheimer
M. Rubber Water Hose:
   1. B.F. Goodrich, BFG General Service Black Cover Hose
   2. Boston Industrial Hose
N. Hose Nozzles:
   1. Akron Brass
   2. Potter Roemer, Figure 2971

2.2 MATERIALS

A. Support and Hanger Materials:
   1. Wetted and submerged: SST.
   2. Atmospheric exposed: Galvanized.
B. Joints: Tight fitting, watertight, and without imperfections; furnish only the Manufacturer's recommended lubricants.
C. Insulating Dielectric Unions and Flanges:
   1. Provide complete electrical isolation across joints. Insulating couplings, unions, or fittings that only electrically isolate the interior of the pipe are not acceptable.
   2. Furnish between ferrous and non-ferrous piping and where otherwise required for electrically insulated connection, including water service line connections to metallic mains, taps on metallic pipe, and any other metallic plumbing connection to metallic pipe.
   3. Materials: Galvanically compatible with piping to which it is attached and pressure ratings suitable for system working pressures.
   4. Unions, 2 inches and smaller: Screwed or solder-joint type.
   5. Unions, 2 1/2 inches and larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.
D. Channel Type Support Systems:
   1. Galvanized: Pre-galvanized in accordance with ASTM B 584, Class G90, or hot-dip galvanized after fabrication.
   2. SST: In accordance with ASTM A 276 Type 304 SST.
   3. Channel size: 12 gauge, 1 5/8 inch wide series.
   4. Members and connections: Designed for loads with a safety factor of 5.
E. Anchoring Systems:
   1. Wetted and submerged: SST.
   2. Atmospheric exposed: Galvanized; coat as specified in SECTION 09 90 00, System No. 29, fusion-bonded coating.
   3. Size: Sized by the Equipment Manufacturer.
F. PVC Piping, Valves, and Fittings: Schedule 80 pipe and fittings, true union ball valves with lever operator.
G. Pipe Sleeves:
   1. Steel pipe sleeve:
      a. Material: Steel pipe, in accordance with ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
      b. Seep ring:
         1) Center steel flange, 3/16 inch minimum thickness, for water stoppage on sleeves in exterior or water-bearing walls.
         2) Outside diameter: 3 inches greater than the outside diameter of the pipe sleeve.
         3) Continuously fillet weld on each side all around.
      c. Factory finish:
         1) Galvanizing:
            a) Hot-dip applied, in accordance with ASTM A 153.
            b) Electroplated zinc and cadmium plating are not acceptable.
   2. PVC pipe sleeve:
      a. For below grade.
      b. In accordance with ASTM D 1785, Schedule 40.
   3. Modular mechanical seal:
      a. Type: Interconnected synthetic rubber links shall be shaped and sized to continuously fill the annular space between pipe and the wall sleeve opening.
      b. Fabrication: Assemble interconnected rubber links with ASTM A 276, Type 316 SST bolts and nuts.
      c. Pressure plates shall be reinforced nylon polymer.

d. Size: In accordance with the Manufacturer's instructions for the size of pipes shown on the Drawings to provide a watertight seal between pipe and the wall sleeve opening and to withstand a hydrostatic head of 40 feet of water.

H. Hose Valves and Hydrants – HB-1, Hose Valve:
1. Cast bronze globe valve, with NPT screwed ends, union bonnet, rising stem, PTFE disc, bronze seat, handwheel, and NPT by 3/4 inch NST hose thread adapter outlet connection.
2. Valve shall be rated 150 psi SWP, 300 psi WOG.

I. Valves and Operators:
1. Each unit shall have the name of the Manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.
2. Epoxy lining and coating:
a. In accordance with AWWA C550.
b. Two-part liquid material or heat-activated (fusion) material, except only heat-activated material if specified as fusion or fusion-bonded epoxy.
c. Minimum 7 mil DFT except where limited by valve operating tolerances.

J. Gate Valves:
1. Type V125 resilient-seated gate valve, 3 inches and larger for water service:
a. As specified in SECTION 33 14 19.
b. Except as modified or supplemented herein, resilient-seated gate valves shall be in accordance with AWWA C509 or AWWA C515.
c. Mechanical joints in accordance with AWWA C111; Tee head bolts and nuts shall be fabricated from a high-strength, low-alloy steel known as Cor-Ten, Usalloy, or DI Durabolt.
d. Provide handwheel for exposed valves and 2-inch operating nuts for buried valves.

K. Globe Valves: Type V200 globe valve, 3 inches and smaller shall be all-bronze, union bonnet, inside screw, rising stem, PTFE disc, rated 150 psi SWP, 300 psi WOG.

L. Ball Valves:
1. Type V300 ball valve, 4 inches and smaller for general water and air service: Bronze, three-piece, full port, blowout proof stem, soldered or threaded ends, RPTFE seats and packing, hand lever operation, rated 150 psi SWP, 600 psi WOG.
2. Type V301 ball valve, 4 inches and smaller for general water service: Type 316 SST body, full port, SST ball, SST seat with stellite overlay, PTFE Chevron packing, SST shaft, flanged ANSI Class 150.
3. Type V302 ball valve, 4 inches and smaller for general water service: Two-piece, copper alloy ball valves: ANSI B16.34, brass 150 WSP, bronze body conforming to ASTM B 584 with full port, chrome-plated brass ball; PTFE seats; and 600 psig minimum CWP rating and blowout proof stem.

M. Plug Valves:
1. Type V462 gauge cock: 1/4 inch bronze body, hexagon end pattern, tee head, female ends, rated 125 psi SWP.
2. Type V464 corporation stop: As specified in SECTION 33 14 17 and AWWA C800, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection, or IPS threads to suit connecting pipe, rated 150 psi.

N. Check Valves: Type V605 check valve, 2 inches and smaller shall be all-bronze, screwed ends and cap, swing type replaceable Buna-N disc, rated 150 psi SWP, 200 psi WOG.

O. Operators:
1. General:
a. Valves shall be equipped with operators. Valve operator types specified herein describe only the general characteristics of the operator.
b. The operator shall be compatible with the valve with which it will be used; it shall be of the same Manufacturer or a product that is recommended by the Valve Manufacturer.
c. The operator shall be sized to operate the valve for the full range of pressures and velocities imposed by service.
2. Manual operator:
a. Operator force shall not exceed 40 lbs under any operating condition, including initial breakaway. Use a gear reduction operator when force exceeds 40 lbs.
b. The operator shall be self-locking or equipped with a self-locking device.
c. Position indicator on quarter-turn valves.
d. Worm and gear operators shall be one-piece design made of bronze material. They shall be hardened alloy steel with the threads ground and polished. Traveling nut type operators shall be threaded steel reach rods with an internally threaded bronze or DI nut.
3. Exposed operator: Painted handwheels.
4. Buried operator:
a. Buried service operators on valves larger than 2 1/2 inches shall have a 2 inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have a cross handle for operation by forked key. Enclose the moving parts of the valve and the operator in housing to prevent contact with soil.
b. Design buried service operators for quarter-turn valves to withstand 450 ft-lbs of input torque at fully open or fully closed positions; they shall be grease-packed and gasketed to withstand submersion in water to 10 psi.
c. Buried valves shall have extension stems, bonnets, and valve boxes.
d. Buried service operators shall be open right or clockwise rotation.

P. Valve Accessories:
   1. Tagging: A 1 1/2 inch heavy brass or SST tag for each valve operator bearing the valve tag number shown on the valve schedule.
Q. Gauge Cock Valves, 1/8 inch to 3/8 inch:
   1. Bronze body, hexagon male and female ends and tee head.
   2. Rated for 125 psi SWP.
R. Rubber Water Hose: Furnish one, 50 foot, 3/4-inch hose. Furnish with brass male and female NST hose thread couplings to fit the hose nozzle(s) and the pipe corporation stop specified.
S. Hose Nozzles: Furnish five, 1 inch cast brass, adjustable, fog-straight stream type, with female NST hose thread.
T. Hose Rack: Fabricated from steel, hot-dip galvanized. The size of the rack shall be adequate to hold 50 feet of 3/4-inch hose. Mount the rack in the vault at a location determined by the OWNER.
U. Pressure Gauge:
   1. 2 1/2-inch dial size, Type 316L SST tube and socket material. 1/4 inch NPT lower connection.
   2. Liquid filled with glycerin.
   3. Bourdon tube: Type 316L SST C-shaped, 1.5% full scale accuracy with liquid filled gauge.
   4. NEMA 4x/IP 65 plug sealed.
   5. Dial range: Dial face and range sized for process pressure.
V. Escutcheons:
   1. Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers the opening.
   2. One-piece, stamped steel type: With chrome-plated finish and set screw or spring clips fasteners.
   3. Split-plate, stamped steel type: With chrome-plated finish, concealed and exposed rivet hinge, and set screw or spring clip fasteners.
W. Stem Type Thermometers:
   1. Adjustable angle, red or blue appearing organic liquid fill, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
      a. Size: 9 inches scale.
      b. Window: Clear glass or Lexan.
      c. Stem: 3/4 inch NPT brass.
      d. Accuracy: In accordance with ASTM E 77, 2%.
      e. Calibration: Degrees Fahrenheit.
X. Thermowells:
   1. In accordance with ASME B40.200.
   2. Description: Pressure tight, socket type fitting made for insertion into piping tee fitting.
   3. Material for use with copper tubing: Copper nickel resistant or copper-nickel alloys.
   4. Material for use with steel piping: Corrosion resistant bronze or SST.
   5. Type: Stepped shank unless straight or tapered shank is as shown on the Drawings.
   6. External threads: Nominal pipe size of 1/2, 3/4, or 1, in accordance with ASME B1.20.1 pipe threads.
   7. Internal threads: 1/2 inch, 3/4 inch, and 1 inch, in accordance with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion length: Length required to match thermometer bulb or stem.
   10. Lagging extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
Y. Copper Piping: As specified in Supplement A.
Z. SST Piping: As specified in Supplement B.

2.3 FABRICATION

A. Use end products of one Manufacturer and similar materials to achieve standardization in appearance and for maintenance and replacement.
B. Where diagrams show piping connections, the CONTRACTOR is cautioned that these diagrams shall not be used for obtaining material quantities.
C. The valve shall include the operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.
D. The valve shall be suitable for its intended service. Renewable parts shall not be of a lower quality than specified.
E. The valve shall be the same size as adjoining pipe unless otherwise noted.
F. Valve ends shall suit adjacent piping.
G. Size the operator to operate the valve for the full range of pressures and velocities.
H. Factory-mount the operator, actuator, and accessories.
I. Bolt holes for flanges for valves having flange insulation kits shall be as specified in SECTION 33 05 24.23 and over-drilled for insulating sleeves.
J. When specified items are not available, fabricate pipe supports of the correct material and to the general configuration indicated by catalogs.
K. Special support and hanger details are shown on the Drawings for cases where standard catalog supports are not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. Field Obstructions:

1. Drawings do not show exact details of all piping. Extra compensation will not be allowed for obstruction caused by the Work of other trades or local obstructions to Work under this Section that require offsets.
2. The preparation of structural components required for fixtures, equipment, and material installed under this Section shall be performed by the particular affected trade.
3. Penetrations required through completed concrete construction shall be core drilled or saw cut at the minimum size required. Penetrations in concrete require an x-ray or ground penetrating radar to determine if the location is clear of reinforcing steel and embedded systems. Precautions shall be taken when drilling to prevent damage to structural concrete.
4. Provide an interpretation of the x-rays or radar shot and obtain written acceptance from the OWNER before proceeding with drilling.

3.2 INSTALLATION

A. Sleeves:

1. Pipe sizes shown on the Drawings are nominal.
2. Furnish piping passing through walls, floors, or ceilings with standard weight pipe sleeves.
3. Pipe sleeves installed in water-holding structures shall have a 1/4-inch steel seep ring that is 4 inches larger in diameter than the outer diameter of the sleeve. Continuously weld the ring to the sleeve.
4. Make the joint between the pipe and the sleeve watertight with a mechanical link seal.
5. Dry pack sleeves in existing walls with grout; provide a finished appearance.
6. Pack holes left by the removal of existing piping with grout and finish.
7. Sleeves are not required for core drilled holes.

B. Install unions in the piping system at the connection to equipment.

C. Pipe air release valves, pressure relief valves, strainer waste, water-lubricated bearings, and other appurtenances having water effluent to the nearest drain with copper tubing.

D. Equipment:

1. Drawings do not show all integral piping and accessories for the equipment to be installed.
2. Install equipment in accordance with the Manufacturer's piping diagrams and instructions.

E. Identification: Label pressure piping with the system operating pressure.

F. Copper Tubing:

1. Cut tubing square and remove burrs.
2. Clean the inside of fittings and the outside of tubing with steel wool before sweating or brazing.
3. Prevent annealing of fittings and hard-drawn tubing when making connections. Wipe off excess solder from the joint to leave a neat appearance.
4. The mitering of joints for elbows and the notching of straight runs of pipe for tees is not permitted.

G. Piping Transition:

1. Applications:
   a. Provide complete closure assembly where pipes meet other pipes or structures.
   b. Pressure pipeline closures: Plain end pieces with double flexible couplings.
   c. Restrained joint pipe closures: Install with thrust tie rod assemblies.
   d. Gravity pipe closures: As specified for pressure pipelines or concrete closures.
   e. Concrete closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
   f. Elastomer sleeves bonded to pipe ends are not acceptable.
2. Installation of flexible transition couplings: Install in accordance with the Coupling Manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in the outside diameter.

H. Tapping Sleeves, Service Saddles, and Thrust Ties:

1. Installation procedures:
   a. Install in accordance with the Manufacturer’s instructions.
   b. Before coupling, clean the pipe holdback area of oil, scale, rust, and dirt.
   c. Remove pipe coating if necessary to present a smooth surface.
   d. Repair or replace pipe coating or wrapping following installation.

I. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Copper to ferrous metal piping connections.
   b. Cathodically protected piping penetration to buildings and watertight structures.
   c. Where required for electrically insulated connection.
2. Installation of insulating kits:
   a. As specified in SECTION 13 47 16.
   b. Drill oversized flange bolt holes to accommodate insulating sleeves through the bolt holes, assuming standard bolt and stud sizes.
3. Pipe installation:
   a. Insulating joints connecting immersed piping to non-immersed piping shall be installed above the maximum water surface elevation.
   b. Submerged carbon steel, DI, or galvanized piping in reinforced concrete basins shall be isolated from concrete reinforcement steel.

J. Valve Installations:
1. Flange ends:
a. Flanged valve bolt holes shall straddle the vertical centerline of pipe.
b. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
2. Screwed ends:
a. Clean threads by wire brushing or swabbing.
b. Apply joint compound.
3. Valve orientation:
a. Install the operating stem vertical when the valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finished floor.
b. Install the operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the finished floor.
c. Orient the butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., the shaft is in the plane of rotation of the eddy.
d. If the plug valve seat position is not shown on the Drawings, locate it as follows:
1) Horizontal flow: Flow shall produce an unseating pressure and plug shall open into the top half of valve.
2) Vertical flow: Install the seat in the highest portion of valve.
4. Extension stem for operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade, furnish an operating extension stem with a 2-inch operating nut to bring the operating nut to a point 6 inches below the surface of the ground or box cover.
5. Torque tube: Where the operator for a quarter-turn valve is located on a floor stand, furnish an extension stem torque tube of a type properly sized for the maximum torque capacity of the valve.
6. Install thermometers in the inlet and outlet of each water heater and inlet and outlet of each domestic hot water storage tank.
7. Install pressure gauges in the building water service entrance into building and inlet and outlet of each PRV.

3.3 QUALITY CONTROL
A. Valve and Piping Tests and Inspection:
1. The valve may be tested while testing pipelines or as a separate step.
2. Test valves to ensure they open and close smoothly with operating pressure on one side and atmospheric pressure on the other; test in both directions for two-way valves and applications.
3. Inspect air and vacuum valves as the pipe is being filled to verify that venting and seating are fully functional.
4. Count and record the number of turns to open and close the valve. Account for any discrepancies with the Manufacturer's data.
5. Set, verify, and record set pressures for relief and regulating valves.
6. The automatic valve shall be tested in conjunction with control system testing.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding the pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that need to be repaired.
8. Repair leaks and defects with new materials and retest piping or portions thereof until satisfactory results are obtained.
B. Insulating Dielectric Unions and Flanges: Test insulating flanges, couplings, and unions as specified in SECTION 13 47 16.
C. Field Tests: Prior to operational startup, inspect and test piping systems for leaks in accordance with the test plan.

3.4 CLEANING
A. Interim Cleaning: Keep piping systems clean and free of debris during installation. Use compressed air to blow through copper and steel piping. Swab out lubricating or cutting oil used on steel piping threads.
B. Final Cleaning: Clean potable water piping by filling and flushing the system with a trisodium phosphate solution. Rinse the system to remove cleaning residue.
C. Disinfect potable pipelines and fittings in accordance with AWWA C651 with an NSF 60 certified sodium hypochlorite solution.
1. Prior to starting Work, verify system is complete, flushed, and clean.
2. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
3. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 mg/L to 80 mg/L residual.
4. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
5. Maintain disinfectant in system for 1 day.
6. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
7. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
8. Take samples no sooner than 1 day after flushing from 10% of outlets and from water entry and analyze in accordance with AWWA C651.

3.5 SUPPLEMENTS
A. Supplement A – Copper and Copper Alloy Pipe, Tubing, and Fittings
B. Supplement B – SST Pipe and Fittings – General Service
C. Supplement C – PVC Pipe and Fittings

END OF SECTION

INTENTIONALLY BLANK

SUPPLEMENT A COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
Tubing	Seamless, in accordance with ASTM B 88 as follows: Potable water (buried) Type K, soft or hard temper Potable water (exposed) Type L, hard drawn Domestic hot water Type L, hard drawn Compressed air service Type L, hard drawn Sample line service Type L, hard drawn No. 1 water (buried) Type K, soft or hard temper No. 1 water (exposed) Type L, hard drawn
Fittings	Commercially pure wrought copper, socket joint, in accordance with ASTM B 75, dimensions in accordance with ASME B 16.22
Flanges	Commercially pure wrought copper, socket joint, in accordance with ASTM B 75, faced and drilled 150 lb in accordance with ASME B 16.24
Bolting	Type 304 or Type 316 SST, Grade B8M hex head bolts or threaded studs in accordance with ASTM A 320 and Grade 8M hex head nuts in accordance with ASTM A 194
Gaskets	1/16 inch thick non-asbestos compression type, full face, red rubber gasket, Johns Manville
Solder	J.W. Harris, bridges, lead free solder; in accordance with ASTM B 32
Brazing	Joints 2 1/2 inches and greater shall be brazed

INTENTIONALLY BLANK

SUPPLEMENT B SST PIPE AND FITTINGS – GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2 Inch and Smaller	Schedule 40S: Type 304 or Type 316 seamless, pickled, and passivated in accordance with ASTM A 312
	2 1/2 Inch thru 6 Inch	Schedule 10S: Rev A as-welded grade, Type 304L or Type 316L in accordance with ASTM A 778
	8 Inch and Larger	Schedule 5S: Rev A as-welded grade, Type 304L or Type 316L in accordance with ASTM A 778
Joints	2 Inch and Smaller	Butt-welded, threaded, or flanged as required or shown on the Drawings
	2 1/2 Inch and Larger	Butt-welded or flanged as required or shown on the Drawings
Fittings	2 Inch and Larger	Threaded Forged: 1,000 CWP, Rev C Grade F304L or Grade F316L in accordance with ASTM A 182
		Butt-Welded: Grade 304L or Grade 316L in accordance with MSS SP-43, as-welded grade, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows in accordance with ASTM A 774
Branch Connections	2 Inch and Larger	Butt-welding tee or reducing tee in accordance with the fittings herein
Flanges	All	Forged SST: Rev C Grade F304L or Grade F316L in accordance with ASTM A 182, slip-on weld neck in accordance with ASME B16.5 Class 150 or Class 300
Unions	2 Inch and Smaller	Threaded Forged: Rev C Grade F304 or Grade F316, 2,000 psi or 3,000 psi WOG, integral ground seats in accordance with ASTM A 182, AAR design in accordance with ASME B16.11, bore to match pipe
Bolting	All	Forged Flanges: Type 304 or Type 316 SST, Grade B8M hex head bolts or threaded studs in accordance with ASTM A 320 and Grade 8M hex head nuts in accordance with ASTM A 194
Gaskets	All Flanges	1/8 inch thick neoprene rubber, durometer hardness No. 80, 1,500 psi minimum tensile strength, 125% minimum elongation; flat ring type for raised face flanges and full face type for flat face flanges, Garlock Style 7797
Thread Lubricant	2 Inch and Smaller	Two-part lubricant/sealant by Loc-Tite

INTENTIONALLY BLANK

SUPPLEMENT C PVC PIPE AND FITTINGS	
Item	**Description**
Piping	Above ground, domestic water piping (recycle and potable) where indicated in Chemical Rooms; in accordance with ASTM 1785 as follows: Schedule 80, socket fittings, and solvent cemented joints
Fittings	Socket fittings, in accordance with ASTM D 2467 for Schedule 80
Joining	Solvent cements for joining PVC piping in accordance with ASTM D 2564; including primer in accordance with ASTM F 656
Transition Fittings	Plastic-to-metal transition fittings shall be as follows: PVC one-piece fitting with the Manufacturer's Schedule 80 equivalent dimensions One end with threaded brass insert and one solvent cement socket or threaded end
Transition Unions	Plastic-to-metal transition unions shall be as follows: PVC four-part union Brass or SST threaded end Solvent cement joint or threaded plastic end Rubber O-ring Union nut
Plastic, Pipe Flange Gaskets, Bolts, Nuts	Type and material recommended by the Piping Manufacturer unless otherwise indicated

INTENTIONALLY BLANK

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for the common Work results for plumbing.

B. Related Sections:

1. SECTION 01 91 00 (.01 or .02) – COMMISSIONING
2. SECTION 05 12 00 – STRUCTURAL STEEL
3. SECTION 08 31 00 – ACCESS DOORS AND PANELS FOR WALLS AND CEILINGS
4. SECTION 09 90 00 – PAINTING AND COATING
5. SECTION 22 00 00 – PLUMBING

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. B1.20.1 – Pipe Threads, General Purpose, Inch

B. American Water Works Association (AWWA):

1. C651 – Disinfecting Water Mains
2. C652 – Disinfection of Water-Storage Facilities

C. American Welding Society (AWS):

1. A5.8 – Specification for Filler Metals for Brazing and Braze Welding
2. D1.1 – Structural Welding Code – Steel
3. D10.1 – Committee on Piping and Tubing
4. Brazing Handbook

D. ASTM International (ASTM):

1. B 32 – Standard Specification for Solder Metal
2. B 813 – Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
3. B 828 – Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
4. D 1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
5. D 2235 – Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
6. D 2657 – Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
7. D 2661 – Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
8. D 2672 – Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
9. D 2846 – Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
10. D 2855 – Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
11. D 3138 – Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
12. D 3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
13. D 3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
14. F 402 – Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in SECTION 08 31 00.

1.5 SUBMITTALS

A. Complete itemized Bill of Material describing components and their interface with other disciplines. Reference Supplement A.

B. The Submittals required in SECTION 22 00 00.

C. Provide the ENGINEER Submittal review comments in written format and include original review comment. Provide documentation with responses in the resubmittal or as a supplemental information document on Submittal dispositions of Final for Construction or Final for Construction as Corrected.
D. Include the complete Manufacturer's descriptive information and Shop Drawings for equipment, material, and devices, including certified outline drawings, arrangement drawings, and dimensional layout drawings,
E. Equipment, models, options, extraneous text, etc. that are not being furnished and that do not apply shall be neatly crossed out.
F. Contract Document equipment and device labels, tags, and identification shall be used in Submittals.
G. Supplements listed in this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 PRODUCTS

2.1 FABRICATION

A. Use end products of one Manufacturer and similar materials to achieve standardization in appearance and for maintenance and replacement.
B. Where diagrams show piping connections, the CONTRACTOR is cautioned these diagrams shall not be used for obtaining material quantities.
C. Valves shall include the operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.
D. Components shall be suitable for their intended service. Renewable parts shall not be of a lower quality than specified.
E. Valve ends shall suit adjacent piping.
F. Factory-mount the operator, actuator, and accessories.
G. When specified items are not available, fabricate pipe supports of the correct material and to the general configuration indicated by catalogs.
H. Special support and hanger details are shown on the Drawings for cases where standard catalog supports are not applicable.

PART 3 EXECUTION

3.1 GENERAL

A. Drawing plans, schematics, and diagrams indicate the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, equipment sizing, and other design considerations. Install piping as indicated unless deviations to the layout are approved on coordination drawings.

3.2 INSTALLATION

A. Piping Systems Common Requirements:
    1. Installation of piping shall be as follows:
        a. In accordance with the the requirements of other Sections specifying piping systems.
        b. In concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
        c. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are not allowed unless specifically indicated otherwise.
        d. Install above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
        e. To permit valve servicing.
        f. At indicated slopes.
        g. Free of sags and bends.
        h. To allow application of insulation.
    2. Install fittings for changes in direction and branch connections.
    3. Select system components with a pressure rating equal to or greater than system operating pressure.
    4. Fire-barrier penetrations: Maintain the indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
    5. Verify final equipment locations for roughing-in.
    6. Refer to equipment specifications for roughing-in requirements.
B. Piping Joint Construction:
    1. Join pipe and fittings in accordance with the following requirements:
        a. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
        b. Remove scale, slag, dirt, and debris from the inside and outside of pipe and fittings before assembly.
        c. Soldered joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to the tube end. Construct joints in accordance with ASTM B 828, using lead free solder alloy complying with ASTM B 32.
        d. Brazed joints: Construct joints in accordance with the AWS Brazing Handbook, using copper-phosphorus brazing filler metal complying with AWS A5.8.
        e. Threaded joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
        f. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
        g. Damaged threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

h. Welded joints: Construct joints in accordance with AWS D10.1.
i. Flanged joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
j. Plastic piping solvent cement joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
1) Comply with ASTM F 402 for the safe handling practice of cleaners, primers, and solvent cements.
2) ABS piping: Join in accordance with ASTM D 2235 and ASTM D 2661 Appendices.
3) CPVC piping: Join in accordance with ASTM D 2846/D 2846M Appendix.
4) PVC pressure piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings in accordance with ASTM D 2672. Join other than schedule number PVC pipe and socket fittings in accordance with ASTM D 2855.
k. PVC non-pressure piping: Join in accordance with ASTM D 2855.
l. PVC to ABS non-pressure transition fittings: Join in accordance with ASTM D 3138 Appendix.
m. Plastic pressure piping gasketed joints: Join in accordance with ASTM D 3139.
n. Plastic non-pressure piping gasketed joints: Join in accordance with ASTM D 3212.
o. PE piping heat-fusion joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D 2657.
p. Plain-end pipe and fittings: Use butt fusion.
q. Plain-end pipe and socket fittings: Use socket fusion.
r. Fiberglass bonded joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with the Pipe Manufacturer's written instructions.

C. Piping Connections:
1. Make connections in accordance with the following, unless otherwise indicated:
a. Install unions, in piping nominal pipe size 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment.
b. Install flanges, in piping nominal pipe size 2 1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment.
c. Dry piping systems: Install dielectric coupling and flanges to connect piping materials of dissimilar metals.
d. Wet piping systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

D. Equipment Installation Common Requirements:
1. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
3. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
4. Install equipment to allow right of way for piping installed at required slope.

E. Paintings and Coatings:
1. Painting of plumbing systems, equipment, and components is specified in SECTION 09 90 00.
2. Damage and touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

F. Concrete Bases:
1. Concrete equipment pads: Anchor plumbing equipment to concrete equipment pads in accordance with the Equipment Manufacturer's written instructions.
a. Concrete compressive strength and reinforcement as specified in SECTION 03 30 00.
b. Construct concrete equipment pads of the dimensions indicated, but not less than 4 inches larger in both directions than the supported unit.
c. Install dowel rods to connect equipment pads to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
d. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
e. Place and secure anchorage devices. Use the supported Equipment Manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
f. Install anchor bolts to elevations required for proper attachment to supported equipment.
g. Install anchor bolts in accordance with the Anchor Bolt Manufacturer's written instructions.

G. Erection of Metal Supports and Anchorages:
1. Refer to SECTION 05 12 00 for structural steel.
2. Refer to painting requirements as specified in SECTION 09 90 00.
3. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
4. Field welding: Comply with AWS D1.1.

H. Grouting:
1. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.

4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

3.3 QUALITY CONTROL

A. ORT Pre-Requisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting, or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER and the ENGINEER, shall be paid by the CONTRACTOR.

1. Field QC:
   a. Approval: The OWNER shall approve preparations for, and witness, leak tests. Plumbing piping shall be tested in accordance with this Section prior to acceptance.
   b. Acceptance criteria: Piping that is free of leakage for the duration if the specified tests shall be accepted.
   c. Piping test preparation:
      1) Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently.
      2) Water is used as test liquid and obtained from a source approved by the OWNER.
      3) Water temperature shall not be below 40ºF nor above 140ºF. The preferred water temperature range is between 60ºF and 100ºF.
      4) Water used for hydrostatic testing shall be free of suspended solids and biologically inert. Chlorination at a level of 0.2 ppm to 1.0 ppm is recommended to prevent biological attack.
      5) Fill the pipeline 1 day before testing and apply test pressure to stabilize system. Use only potable water.
   d. Hydrostatic tests:
      1) Test at not less than 1 1/2 times working pressure for 2 hours.
      2) Increase pressure in 50 psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat the test until leakage is within allowed limits.
   e. Post-leak test requirements:
      1) After leak testing has been successfully completed and the results approved by the OWNER, the following operations shall be carried out:
         a) Draining of test fluid: The pressure shall be released, and the system shall be drained from the downstream side of check valves. Vents shall be opened before draining to facilitate drainage and to prevent the formation of a vacuum. No test fluid shall remain in low points.
         b) Disposal of test fluid: As directed by the OWNER.
         c) Test vents and drains: Used only for the pressure test, removed, and the connections permanently sealed.
         d) Removal and reconnection of components:
            (1) Temporary items installed for testing purposes (e.g., manifolds, valves, blinds, spacers, and supports) shall be removed.
            (2) Items that were removed for testing shall be reinstalled.
            (3) Items such as instrument air tubing, etc., which were disconnected before testing, shall be reconnected.
            (4) Isolation valves that were closed for the test and that are required to be in the open position for process reasons shall be opened. If the valve cavity has a drain, the cavity shall be drained.
            (5) Paddle blinds and spectacle blinds shall be removed.
            (6) Use new gaskets when reassembling flanged joints that were disassembled for testing purposes. Do not reuse gaskets.
   f. Prepare reports of testing activities.

3.4 STARTUP

A. Startup and commissioning activities shall generally include operational readiness testing for each individual equipment item, system acceptance testing of each subsystem, and each system as a unit process or complete treatment system, followed by facility reliability testing. Further requirements for each type of test are as specified in SECTION 01 91 00 and this Section.

B. Specific testing applicable to plumbing systems includes:

1. Operational readiness testing:
   a. Valve tests and inspection:
      1) The valve may be tested while testing pipelines or as a separate step.
      2) Test valves to ensure they open and close smoothly with operating pressure on one side and atmospheric pressure on the other; test in both directions for two-way valves and applications.
      3) Inspect air and vacuum valves as the pipe is being filled to verify that venting and seating are fully functional.
      4) Count and record the number of turns to open and close the valve. Account for any discrepancies with the Manufacturer's data.
      5) Set, verify, and record set pressures for relief and regulating valves.
      6) The automatic valve shall be tested in conjunction with control system testing.

b. Field tests: Prior to operational startup, inspect and test piping systems for leaks in accordance with the test plan.

3.5 CLEANING

A. Interim cleaning: Keep piping systems clean and free of debris during installation. Use compressed air to blow through copper and steel piping. Swab out lubricating or cutting oil used on steel piping threads.

B. Final cleaning: Clean potable water piping by filling and flushing the system with a trisodium phosphate solution. Rinse the system to remove cleaning residue.

C. Clean and disinfect pipelines intended to carry potable water before placing them in service as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by the AHJs; if methods are not prescribed, use the procedures described in AWWA C651 or AWWA C652 or the following procedures:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system in accordance with either of the following:
        1) Fill system or part thereof with a water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with a water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to the AHJs.
3. Prepare and submit reports of purging and disinfecting activities. Include copies of water sample approvals from the AHJs.
4. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.6 SUPPLEMENTS

A. Supplement A – Example Bill of Material

INTENTIONALLY BLANK

SUPPLEMENT A – EXAMPLE BILL OF MATERIAL
Administration Building Plumbing
Contract #: --

Submittal #: --

Equipment/ Specification:	Item	Qty.	Description	Manufacturer	Complete Manufacturer Part No. (with all options):	DW Device Abbrev/Tag

INTENTIONALLY BLANK

SECTION 22 05 33
HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for heat tracing for plumbing piping.
- B. Related Sections:
  1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
  2. SECTION 01 33 00 – SUBMITTAL PROCEDURES
  3. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
  4. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
  5. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
  6. SECTION 26 05 26 – GROUNDING AND BONDING

1.2 REFERENCES
- A. Institute of Electrical and Electronics Engineers (IEEE):
  1. 515.1 – Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Commercial Applications
- B. National Fire Protection Association (NFPA):
  1. 70 – National Electrical Code (NEC)

1.3 SUBMITTALS
- A. Warranty documentation as specified in SECTION 01 60 00.
- B. O&M documentation as specified in SECTION 01 78 23.
- C. Action Submittals:
  1. Product data for each type of product.
     a. Include rated capacities, operating characteristics, and furnished specialties and accessories.
     b. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
     c. Include data substantiating that materials are in accordance with requirements.
  2. Shop Drawings for electric heating cable:
     a. Include drawings, elevations, sections, and attachment details.
     b. Include diagrams for power, signal, and control wiring.
- D. Informational Submittals:
  1. Field QC reports.
  2. Sample warranty: For special warranty.
- E. Closeout Submittals:
  1. O&M data for electric heating cables to include in O&M manuals.
  2. Submit complete As-Builts Drawings of Work, including interface with other Work, as specified in SECTION 01 33 00. Record actual locations of components.
- F. O&M Special Requirements: As specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).

1.4 QUALITY ASSURANCE
- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the Following Tests and Inspections:
  1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
  2. Test cables for electrical continuity and insulation integrity before energizing.
  3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Replace damaged or defective components of heat tracing system, and retest to verify function and compliance in accordance with the Specifications and Project requirements.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. As specified in SECTION 01 60 00.

1.6 WARRANTY
- A. As specified in SECTION 01 60 00. Specific requirements in addition to these Sections shall be:
  1. Special warranty: The Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
     a. Warranty period: A minimum of 5 years from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Self-Regulating, Parallel Resistance Heating Cables:
  1. BriskHeat
  2. Chromalox
  3. Delta-Therm Corporation
  4. Easy Heat; a division of EGS Electrical Group LLC
  5. Nelson Heat Trace; a division of EGS Electrical Group LLC

6. Pyrotenax; a brand of Tyco Thermal Controls LLC
7. Raychem; a brand of Tyco Thermal Controls LLC
8. Thermon Americas Inc.
9. Trasor Corp.

2.2 COMPONENTS

A. Self-Regulating, Parallel Resistance Heating Cables:
1. Cables: In accordance with IEEE 515.1.
2. Heating element: Pair of parallel No. 16 American wire gauge nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
3. Electrical insulating jacket: Flame retardant polyolefin.
4. Cable cover: Tinned copper, braid, and polyolefin outer jacket with UV inhibitor.
5. Maximum operating temperature (power on): 150°F electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Capacities and characteristics:
   a. Maximum heat output: 8 W/ft.
   b. Number of parallel cables: Two.
   c. Electrical characteristics for single circuit connection:
      1) 208 V.
      2) Phase: 1.
      3) 60 Hz.
      4) Minimum circuit ampacity: 40.
      5) Provide contacts rated for running and alarm status rated 5 A at 120 VAC as shown on the Drawings.

B. Controls:
1. Pipe-mounted thermostats for freeze protection: Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

2.3 ACCESSORIES

A. Cable installation accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips furnished by the Manufacturer, or as recommended in writing by the Manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Applications: Install electric heating cable for overflow roof drains.

B. Installation:
1. Electric heating cable installation for freeze protection for piping: Install electric heating cables, in accordance with IEEE 515.1, after piping has been tested and before insulation is installed.
2. Set field-adjustable switches and circuit breaker trip ranges.

C. Connections:
1. Ground equipment as specified in SECTION 26 05 26.
2. Connect wiring as specified in SECTION 26 05 19.

3.3 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace damaged heat tracing cables.

END OF SECTION

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for domestic water piping specialties.

B. Related Sections:

1. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
2. SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
3. SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING
4. SECTION 22 11 00 – FACILITY WATER DISTRIBUTION
5. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
6. SECTION 26 05 26 – GROUNDING AND BONDING

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. A112.18.1 – Plumping Supply Fittings
2. A112.21.3M – Hydrants for Utility and Maintenance Use
3. B1.20.7 – Hose Coupling Screw Threads (Inch)

B. American Society of Safety Engineers (ASSE):

1. 1010 – Performance Requirements for Water Hammer Arresters
2. 1011 – Performance Requirements for Hose Connection Vacuum Breakers
3. 1017 – Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems

C. Manufacturers Standardization Society (MSS):

1. SP-110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

D. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 – Drinking Water System Components – Health Effects

E. Plumbing and Drainage Institute (PDI):

1. WH 201 – Water Hammer Arresters

F. Underwriters Laboratory, Inc. (UL):

1. 486A/486B – Wire Connectors

1.3 SUBMITTALS

A. Action Submittals:

1. Product data for each type of product:
   a. Provide component sizes, rough-in requirements, service sizes, and finishes.
   b. Include data substantiating that materials comply with requirements.

B. Shop Drawings for domestic water piping specialties:

1. Include diagrams for power, signal, and control wiring.
2. For fabricated items, indicate dimensions, weights, and placement of openings and holes.

C. Informational Submittals: Field QC reports.

D. Closeout Submittals:

1. Project record documents:
   a. Record actual locations of equipment, cleanouts, and BFPAs.
   b. As-Built Drawings shall be provided in the same format and manner as specified in this Section. Each set shall be equipped with a plan holder equal to “Stacor Plan Clamps” for the appropriate size Drawings.

E. O&M Data: For domestic water piping specialties to include in emergency and O&M manuals.

1. Indicate the frequency of treatment required for interceptors.
2. Include the installation instructions, spare parts lists, and exploded assembly views.

F. Spare Parts:

1. Provide two each of loose keys hose end vacuum breakers.
2. Water filter cartridges: Provide two for each type and size as shown on the Drawings.
3. Operating key handles: Provide two for each key-operated hose bibb and hydrant installed.

1.4 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by the same Manufacturer throughout.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Construction Waste Management: As specified in SECTION 01 74 19. Documentation shall be submitted to satisfy the requirements of that Section.

B. Deliver, store, protect, and handle products as specified in SECTION 01 60 00 and SECTION 22 05 00.

C. Accept specialties on-site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. BFPAs:

1. As specified in SECTION 22 11 00

B. Water PRVs:

1. Water regulators:
   a. As specified in SECTION 22 11 00

C. Balancing Valves:

1. Copper-alloy calibrated balancing valves:
   a. Armstrong International, Inc.

b. Flo Fab Inc.
c. ITT Corporation; Bell & Gossett Div.
d. NIBCO Inc.
e. TAC
f. TACO Inc.
g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company

D. Temperature-Actuated, Water Mixing Valves:
1. Primary, thermostatic, water mixing valves:
a. Armstrong International, Inc.
b. Bradley
c. Lawler Manufacturing Company, Inc.
d. Leonard Valve Company
e. Powers; a division of Watts Water Technologies, Inc.
f. Symmons Industries, Inc.

E. Outlet Boxes:
1. Icemaker outlet boxes:
a. Acorn Engineering Company
b. IPS Corporation
c. LSP Products Group, Inc.
d. Oatey
e. Plastic Oddities

F. Hose Bibbs:
1. Jay R. Smith Manufacturing Company
2. Josam Manufacturing Company
3. Woodford
4. Zurn Industries

G. Wall Hydrants:
1. Non-freeze wall hydrants:
a. Josam Company
b. MIFAB, Inc.
c. Prier Products, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products
g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products

H. Water Hammer Arresters:
1. AMTROL, Inc.
2. Josam Company
3. MIFAB, Inc.
4. Precision Plumbing Products, Inc.
5. Sioux Chief Manufacturing Company, Inc.
6. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
7. Tyler Pipe; Wade Div.
8. Watts Drainage Products
9. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products

I. Flexible Connectors:
1. Flex-Hose Co., Inc.
2. Flexicraft Industries
3. Flex Pression, Ltd.
4. Flex-Weld Inc.
5. Hyspan Precision Products, Inc.
6. Mercer Gasket & Shim, Inc.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. TOZEN Corporation
10. Unaflex
11. Universal Metal Hose; a Hyspan company

2.2 COMPONENTS
A. Potable water piping and components shall be in accordance with NSF/ANSI 61.
B. Minimum working pressure for domestic water piping specialties: 125 psig.
C. BFPAs: As specified in SECTION 22 11 00.
D. Water PRVs:
1. Water regulators: As specified in SECTION 22 11 00.

E. Balancing Valves:
   1. Copper-alloy calibrated balancing valves:
      a. Type: Ball valve with two readout ports and memory-setting indicator.
      b. Body: Brass
      c. Size: Same as connected piping, but not larger than nominal pipe size 2.
      d. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
F. Temperature-Actuated, Water Mixing Valves:
   1. Primary, thermostatic, water mixing valves:
      a. In accordance with ASSE 1017.
      b. Pressure rating: 125 psig minimum unless otherwise shown on the Drawings.
      c. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
      d. Material: Bronze body with corrosion-resistant interior components.
      e. Connections: Threaded union inlets and outlet.
      f. Accessories: Manual temperature control, check stops on hot-water and cold-water supplies, and adjustable, temperature-control handle.
      g. Valve finish: Rough bronze.
      h. Piping finish: Chrome plated copper.
G. Strainers for Domestic Water Piping:
   1. Y-pattern strainers:
      a. Pressure rating: 125 psig minimum unless otherwise shown on the Drawings.
      b. Body: Bronze for nominal pipe size 2 and smaller; CI with interior lining in accordance with AWWA C550 or that is FDA approved, epoxy-coated for nominal pipe size 2 1/2 and larger.
      c. End connections: Threaded for nominal pipe size 2 and smaller; flanged for nominal pipe size 2 1/2 and larger.
      d. Screen: SST with round perforations unless otherwise shown on the Drawings.
      e. Perforation size:
         1) Strainers nominal pipe size 2 and smaller: 0.020 inches.
         2) Strainers nominal pipe size 2 1/2 to nominal pipe size 4: 0.045 inches.
         3) Drain: Factory-installed, hose end drain valve.
H. Outlet Boxes:
   1. Icemaker outlet boxes:
      a. Mounting: Recessed.
      b. Material and finish: Epoxy-painted-steel box and faceplate.
      c. Faucet: Valved fitting in accordance with ASME A112.18.1. Include nominal pipe size 1/2 or smaller copper tube outlet.
      d. Supply shutoff fitting: Nominal pipe size 1/2 gate, globe, or ball valve and nominal pipe size 1/2 copper, water tubing.
I. Hose Bibbs:
   1. In accordance with ASME A112.18.1 for sediment faucets.
   2. Body material: Bronze.
   3. Seat: Bronze, replaceable.
   4. Supply connections: Nominal pipe size 1/2 or nominal pipe size 3/4 threaded or solder-joint inlet.
   5. Outlet connection: Garden hose thread in accordance with ASME B1.20.7.
   6. Pressure rating: 125 psig otherwise shown on the Drawings.
   7. Vacuum breaker: Integral or field-installation, non-removable, drainable, hose connection vacuum breaker in accordance with ASSE 1011.
   8. Finish for equipment rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for service areas: Rough bronze, or chrome or nickel plated.
   10. Finish for finished rooms: Chrome or nickel plated.
   11. Operation for equipment rooms: Wheel handle or operating key.
   12. Operation for service areas: Wheel handle or operating key.
   13. Operation for finished rooms: Operating key.
   14. Include operating key with each operating-key hose bibb.
   15. Include integral wall flange with each chrome-plated or nickel-plated hose bibb.
   16. Interior mixing: Bronze or brass, wall-mounted, double service faucet with hose thread spout, integral stops, chrome plated where exposed with handwheels, and vacuum breaker in accordance with ASSE 1011.
J. Wall Hydrants:
   1. Non-freeze wall hydrants in accordance with ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
      a. Pressure rating: 125 psig otherwise shown on the Drawings.
      b. Operation: Loose key.
      c. Casing and operating rod: Of the length required to match wall thickness. Include wall clamp.
      d. Inlet: Nominal pipe size 3/4 or nominal pipe size 1.
      e. Outlet: Concealed, with integral vacuum breaker and garden hose thread in accordance with ASME B1.20.7.
      f. Box: Deep, flush mounted, lockable, with cover.
      g. Box and cover finish: Chrome plated.

K. Drain Valves:
1. Ball valve type, hose end drain valves:
a. In accordance with MSS SP-110 for standard port, two-piece ball valves.
b. Pressure rating: 400 psig minimum CWP.
c. Size: Nominal pipe size 3/4.
d. Body: Copper alloy.
e. Ball: Chrome-plated brass.
f. Seats and seals: Replaceable.
g. Handle: Vinyl-covered steel.
h. Inlet: Threaded or solder joint.
i. Outlet: Threaded, short nipple with garden hose thread in accordance with ASME B1.20.7 and cap with brass chain.

L. Water Hammer Arresters:
1. In accordance with ASSE 1010 or PDI WH 201.
2. Type: Provide full SST construction, metal bellows type with pressurized metal cushioning chamber, pre-charged, suitable for operation in temperature range -100°F to 300°F and maximum 250 psig working pressure.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI WH 201, Sizes A through F.

M. Air Vents:
1. Bolted construction automatic air vents:
a. Body: Bronze.
b. Pressure rating and temperature: 125 psig minimum pressure rating at 140°F.
c. Float: Replaceable, corrosion-resistant metal.
d. Mechanism and seat: SST.
e. Size: Nominal pipe size 3/8 nominal pipe size 1/2 minimum inlet.
f. Inlet and vent outlet end connections: Threaded.

N. Flexible Connectors:
1. Bronze hose flexible connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working pressure rating: Minimum 200 psig.
b. End connections nominal pipe size 2 and smaller: Threaded copper pipe or plain-end copper tube.
c. End connections nominal pipe size 2 1/2 and larger: Flanged copper alloy.
d. SST hose flexible connectors: Corrugated SST tubing with SST wire-braid covering and ends welded to inner tubing.
e. Working pressure rating: Minimum 200 psig.
f. End connections nominal pipe size 2 and smaller: Threaded steel pipe nipple.
g. End connections nominal pipe size 2 1/2 and larger: Flanged steel nipple.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install BFPAs in each water supply to the mechanical equipment, mechanical systems, and to other equipment and water systems that may be sources of contamination. Comply with the AHJ.
1. Locate BFPAs in the same room as connected equipment or system.
2. Install drains for the BFPAs with an atmospheric vent drain connection with an air-gap fitting, a fixed air-gap fitting, or an equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate the air-gap device attached to or under the BFPA. Simple air breaks are unacceptable for this application.
3. Do not install the bypass piping around the BFPAs.

B. Install water regulators with inlet and outlet shutoff valves and bypass with a memory-stop balancing valve. Install pressure gauges on the inlet and the outlet.
C. Install strainers on the supply side of each control valve, pressure regulator, and solenoid valve.
D. Install balancing valves in the locations where they can easily be adjusted.
E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on the inlets and with a shutoff valve on the outlet.
F. Install Y-pattern strainers for water on the supply side of each control valve, water PRV, solenoid valve, and pump.
G. Install water hammer arresters in the water piping in accordance with PDI WH 201.
H. Install air vents at high points of the water piping. Install drain piping and discharge onto the floor drain.
I. Install water hammer arrestors complete with an accessible isolation valve on the hot and cold water supply piping to the lavatories, sinks, and washing machine outlets.
J. Fasten wall hanging plumbing specialties securely to the supports attached to the building substrate if supports are specified and to the building wall construction if no support is shown on the Drawings.
K. Fasten recessed type plumbing specialties to the reinforcement built into the walls.
L. Install wood blocking reinforcement for wall mounting and recessed type plumbing specialties. Use carriers when possible.
M. Install individual shutoff valves in each water supply to the plumbing specialties. Use a ball, gate, or globe valve if specific valve is not shown on the Drawings. Install shutoff valves in accessible locations.
N. Include a ball, gate, or globe valve in the inlet and drain piping from the outlet to the floor drain.
O. Install traps on the plumbing specialty drain outlets. Omit traps on indirect wastes unless a trap is shown on the Drawings.

P. Install escutcheons at the wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons if required to conceal protruding pipe fittings.
Q. Connections:
1. Requirements for ground equipment as specified in SECTION 26 05 26. Fire retardant treated wood blocking as specified in SECTION 26 05 19 for electrical connections.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Tighten electrical connectors and terminals in accordance with the Manufacturer's published torque-tightening values. If the Manufacturer's torque values are not shown on the Drawings, use those in accordance with UL 486A/486B.
4. Connect plumbing specialties and devices that require power as specified in SECTION 26 05 19.
R. Labeling and Identifying:
1. Install an engraved plastic laminate equipment nameplate or sign on or near each of the following:
a. RP BFPAs.
b. Water PRVs.
c. Calibrated balancing valves.
d. Primary, thermostatic, water mixing valves.
e. Hose stations.
2. Distinguish among multiple units, inform the operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying the unit.

3.2 QUALITY CONTROL
A. Perform the following tests and inspections:
1. Test each RP BFPA in accordance with the AHJ and the device's reference standard.
2. Manufacturer's field service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing.
3. Leak test: After installation, charge the system and test for leaks. Repair leaks and retest until no leaks exist.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.

3.3 ADJUSTING
A. Set field adjustable pressure SPs of water PRVs, flow SPs of balancing valves, and temperature SPs of temperature-actuated, water mixing valves.

END OF SECTION

INTENTIONALLY BLANK

SECTION 22 14 00
STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for storm drainage piping.
- B. Related Sections:
  1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
  2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
  3. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
  4. SECTION 22 14 23 – STORM DRAINAGE PIPING SPECIALTIES

1.2 REFERENCES
- A. American Society of Civil Engineers (ASCE):
  1. 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- B. American Society of Testing and Materials (ASTM):
  1. A 48 – Standard Specification for Gray Iron Castings
  2. A 888 – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
  3. C 564 – Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  4. C 1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems
  5. C 1277 – Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
  6. C 1540 – Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
  7. D 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
  8. D 2564 – Standard Specification for Solvent Cements for Poly Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems
  9. D 2665 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
  10. D 2855 – Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets
  11. D 3311 – Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
  12. D 5926 – Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
  13. F 402 – Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
  14. F 477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  15. F 656 – Standard Specification for Primers for Use in Solvent Cement Joints of (PVC) Plastic Pipe and Fittings
  16. F 891 – Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
- C. Cast Iron Soil Pipe Institute (CISPI):
  1. 301 – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
  2. 310 – Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
  3. Cast Iron Soil Pipe and Fittings Handbook
- D. Environmental Protection Agency (EPA):
  1. 40 CFR 59, Subpart D – National Volatile Organic Compound Emission Standards for Architectural Coatings
- E. Manufacturers Standardization Society (MSS):
  1. SP-69 – Pipe Hangers and Supports – Selection and Application
- F. NSF International/American National Standards Institute (NSF/ANSI):
  1. 14 – Plastics Piping System Components and Related Materials

1.3 SUBMITTALS
- A. Warranty documentation as specified in SECTION 01 60 00.
- B. O&M documentation as specified in SECTION 01 78 23.
- C. Product data for each type of product.
- D. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from the Manufacturer.
  1. Basis for certification: Indicate whether withstand certification is based on an actual test of assembled components or on a calculation.
  2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field QC reports.
- F. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).
- G. Spare Parts: Shipment requirements for spare parts as specified in SECTION 01 60 00.

1.4 QUALITY ASSURANCE
- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated in this Section:
  1. Storm drainage piping: 10 foot head of water.
  2. Storm drainage, force-main piping: 50 psi gauge.

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined in accordance with ASCE 7.
C. Piping materials shall bear the label, stamp, or other markings of the specified testing agency.
D. In accordance with NSF/ANSI 14 for plastic piping components. Include marking with "NSF-DRAIN" for plastic drain piping and "NSF-SEWER" for plastic sewer piping.

1.5 DELIVERY, STORAGE, AND HANDLING
A. As specified in SECTION 01 60 00.

1.6 SITE CONDITIONS
A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by the OWNER or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated in this Section:
1. Notify the Construction Project Manager no fewer than 2 days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without the Construction Project Manager's written permission.

1.7 WARRANTY
A. As specified in SECTION 01 60 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
A. Hubless, CI Soil Pipe and Fittings:
1. CISPI, Hubless Piping Couplings:
a. ANACO-Husky
b. Dallas Specialty & Mfg. Co.
c. Fernco Inc.
d. Matco-Norca, Inc.
e. MIFAB, Inc.
f. Mission Rubber Company, a division of MCP Industries, Inc.
g. Stant
h. Tyler Pipe
2. Heavy-Duty, Hubless Piping Couplings:
a. ANACO-Husky
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Stant
g. Tyler Pipe
3. CI, Hubless Piping Couplings:
a. MG Piping Products Company
B. Specialty Pipe Fittings:
1. Unshielded, non-pressure transition couplings:
a. Dallas Specialty & Mfg. Co.
b. Fernco Inc.
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
2. Pressure transition couplings:
a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. EBAA Iron, Inc.
d. Ford Meter Box Company, Inc.
e. JCM Industries, Inc.
f. Romac Industries, Inc.
g. Smith-Blair, Inc.; a Sensus company
h. Viking Johnson; c/o Mueller Co.

2.2 COMPONENTS
A. Piping Materials: In accordance with requirements of this Section for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Hubless, CI Soil Pipe and Fittings:
1. Pipe and fittings: In accordance with ASTM A 888 or CISPI 301.
2. CISPI, hubless piping couplings:
a. In accordance with ASTM C 1277 and CISPI 310.
b. SST corrugated shield with SST bands and tightening devices; and in accordance with ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-duty, hubless piping couplings:
a. In accordance with ASTM C 1277 and ASTM C 1540.
b. SST shield with SST bands and tightening devices; and in accordance with ASTM C 564, rubber sleeve with integral, center pipe stop.

4. CI, hubless piping couplings:
    a. In accordance with ASTM C 1277.
    b. Two-piece in accordance with ASTM A 48/A 48M, CI housing; SST bolts and nuts; and in accordance with ASTM C 564, rubber sleeve with integral, center pipe stop.

C. PVC Pipe and Fittings:
1. Solid wall PVC pipe: In accordance with ASTM D 2665, drain, waste, and vent.
2. Cellular core PVC pipe: In accordance with ASTM F 891, Schedule 40.
3. PVC socket fittings: In accordance with ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
4. Adhesive primer:
    a. In accordance with ASTM F 656.
    b. VOC content of 550 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA method 24).
    c. In accordance with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.
5. Solvent cement:
    a. In accordance with ASTM D 2564.
    b. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA method 24).
    c. In accordance with the testing and product requirements of the California Department of Health Services' Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

D. Specialty Pipe Fittings:
1. Transition couplings:
    a. General requirements: Fitting or device for joining piping with small differences in the OD or of different materials. Include end connections the same size as and compatible with the pipes to be joined.
    b. Fitting type transition couplings: Manufactured piping coupling or specified piping system fitting.
    c. Unshielded, non-pressure transition couplings:
        1) In accordance with ASTM C 1173.
        2) Elastomeric, sleeve type, reducing or transition pattern. Include shear ring and corrosion-resistant metal tension band and tightening mechanism on each end.
        3) Sleeve materials:
            a) For CI soil pipes: In accordance with ASTM C 564, rubber.
            b) For plastic pipes: In accordance with ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
            c) For dissimilar pipes: In accordance with ASTM D 5926, PVC or other material compatible with the pipe materials being joined.

PART 3 EXECUTION

3.1 INSTALLATION

A. Piping Installation:
1. Drawings, schematics, and diagrams indicate the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as shown unless deviations from layout are approved on the coordination Drawings.
2. Install piping in the following areas:
    a. In concealed locations unless otherwise shown on the Drawings and except in equipment rooms and service areas indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically shown on the Drawings.
    b. Above accessible ceilings to allow sufficient space for ceiling panel removal to permit valve servicing.
    c. At the slopes shown on the Drawings.
3. Piping shall be free of sags and bends and allow for the application of insulation.
4. Install fittings for changes in direction and branch connections.
5. Make changes in direction for storm drainage piping using appropriate branches, bends, and long sweep bends. Do not change direction of flow more than 90 degrees. Use the proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing the size of drainage piping in the direction of flow is prohibited.
6. Lay buried building storm drainage piping beginning at the low point of each system. Install true to the grades and alignment shown on the Drawings, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets in accordance with the Manufacturer's instructions for the use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
7. Install storm drainage piping at the following minimum slopes unless otherwise shown on the Drawings:
    a. Building storm drain & horizontal storm drainage piping: 2% downward in the direction of the flow.
8. Install CI soil piping in accordance with the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.
9. Install underground PVC piping in accordance with ASTM D 2321.
10. Plumbing specialties: Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity flow piping. Install a cleanout fitting with closure plug inside the building in storm drainage force main piping meeting the requirements specified in SECTION 22 14 23. Install drains in storm drainage gravity flow piping as specified in SECTION 22 14 23.
11. Do not enclose, cover, or put piping into operation until it is inspected and approved by the AHJs.

B. Joint Construction:
   1. Hubless, CI soil piping coupled joints: Join in accordance with CISPI 310 and the CISPI Cast Iron Soil Pipe and Fittings Handbook for hubless piping coupling joints.
   2. Plastic, non-pressure piping, solvent cemented joints: Clean and dry joining surfaces.
      a. Join pipe and fittings in accordance with ASTM F 402 for the safe handling practice of cleaners, primers, and solvent cements.
      b. Join PVC piping in accordance with ASTM D 2855 and ASTM D 2665 Appendices.

C. Specialty Pipe Fitting Installation:
   1. Transition couplings:
      a. Install at joints of piping with small differences in the OD.
      b. In drainage piping, install shielded, non-pressure transition couplings.

D. Hanger and Support Installation:
   1. Install carbon steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install SST pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install SST pipe support clamps for vertical piping in corrosive environments.
   5. Vertical piping: In accordance with MSS type 8 or type 42, clamps.
   6. Individual, straight, horizontal piping runs:
      a. 100 feet and less: In accordance with MSS type 1, adjustable, steel clevis hangers.

E. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

F. Support vertical piping and tubing at base and at each floor.

G. Rod diameter may be reduced one size for double-rod hangers, with 3/8 inch minimum rods.

H. Install hangers for CI soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. Nominal pipe size 3: 60 inches with 1/2-inch rod.
   2. Nominal pipe sizes 4 and 5: 60 inches with 5/8-inch rod.
   3. Nominal pipe sizes 6 and 8: 60 inches with 3/4-inch rod.
   4. Spacing for 10 feet pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

I. Install supports for vertical CI soil piping every 15 feet.

J. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. Nominal pipe size 3: 12 feet with 1/2-inch rod.
   2. Nominal pipe sizes 4 and 5: 12 feet with 5/8-inch rod.
   3. Nominal pipe sizes 6 and 8: 12 feet with 3/4-inch rod.

K. Install supports for vertical steel piping every 15 feet.

L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. Nominal pipe sizes 4 and 5: 48 inches with 5/8-inch rod.
   2. Nominal pipe sizes 6 and 8: 48 inches with 3/4-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed herein in accordance with MSS SP-69 and the Manufacturer's instructions.

O. Connections:
   1. Drawings indicate the general arrangement of piping, fittings, and specialties.
   2. Connect interior storm drainage piping to exterior storm drainage piping. Use a transition fitting to join dissimilar piping materials.
   3. Connect storm drainage piping to roof drains and storm drainage specialties.
      a. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with a cover flush with the floor.
   4. Where installing piping adjacent to equipment, allow space for the service and maintenance of equipment.
   5. Make connections in accordance with the following unless otherwise shown on the Drawings:
      a. Install unions, in piping nominal pipe size 2 and smaller, adjacent to each valve and at the final connection to each piece of equipment.
      b. Install flanges, in piping nominal pipe size 2 1/2 and larger, adjacent to flanged valves and at the final connection to each piece of equipment.

P. Identification: Identify exposed storm drainage piping.

3.2 QUALITY CONTROL

A. ORT Prerequisite Activities: The following specified activities will generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER and the ENGINEER, shall be paid by the CONTRACTOR.
   1. During installation, notify the AHJs at least 1 day before inspection shall be made. Perform the tests specified herein in their presence.
      a. Roughing-in inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
      b. Final inspection: Arrange for final inspection by the AHJs to observe the tests specified herein and to ensure compliance in accordance with requirements.
   2. Re-inspection: If the AHJs find that piping will not pass the test or inspection, make the required corrections and arrange for re-inspection.
   3. Reports: Prepare inspection reports and have them signed by the AHJs.

4. Test storm drainage piping in accordance with the procedures of the AHJs or, in the absence of published procedures, as follows:
    a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of piping tested.
    b. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose Work that was covered or concealed before it was tested.
    c. Test procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in the piping system and fill with water to the point of overflow, but not less than 10 feet head of water. From 15 minutes before inspection starts until the completion of inspection, the water level shall not drop. Inspect joints for leaks.
    d. Repair leaks and defects with new materials and retest piping, or a portion thereof, until satisfactory results are obtained.
    e. Prepare reports for tests and required corrective action.

3.3 CLEANING

A. Clean interior of piping. Remove dirt and debris as Work progresses.
B. Protect drains during the remainder of the construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction Work.
C. Place plugs in the ends of uncompleted piping at the end of day and when Work stops.

3.4 STORM DRAINAGE PIPING SCHEDULE

A. Flanges and unions may be used on above ground pressure piping unless otherwise shown on the Drawings.
B. Above ground storm drainage piping nominal pipe size 6 and smaller shall be any of the following:
    1. Service class, CI soil pipe and fittings; gaskets; and gasketed joints.
    2. Hubless, CI soil pipe and fittings; in accordance with CISPI, heavy-duty, hubless piping couplings; and coupled joints.
C. Underground storm drainage piping nominal pipe size 6 and smaller shall be any of the following:
    1. Solid wall PVC pipe, PVC socket fittings, and solvent cemented joints.
    2. Dissimilar pipe material couplings: Unshielded, non-pressure transition couplings.

END OF SECTION

INTENTIONALLY BLANK

SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for storm drainage piping specialties.
- B. Related Sections:
  1. SECTION 01 32 16 (.01 or .02) – COST LOADED SCHEDULE
  2. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
  3. SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA
  4. SECTION 22 14 00 – STORM DRAINAGE PIPING

1.2 REFERENCES
- A. American Society of Mechanical Engineers (ASME):
  1. A112.6.4 – Roof, Deck and Balcony Drains
  2. A112.14.1 – Backwater Valves
  3. A112.36.2M – Cleanouts
- B. ASTM International (ASTM):
  1. A 74 – Standard Specification for Cast Iron Soil Pipe and Fittings
  2. A 48 – Standard Specification for Gray Iron Castings
  3. A 653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  4. A 888 – Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
  5. B 32 – Standard Specification for Solder Metal
  6. B 152 – Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
  7. D 4068 – Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water–Containment Membrane
  8. E 814 – Standard Test Method for Fire Tests of Penetration Firestop Systems

1.3 SUBMITTALS
- A. Warranty documentation as specified in SECTION 01 60 00.
- B. O&M documentation as specified in SECTION 01 78 23.
- C. Product data for each type of product indicated in this Section.
- D. O&M data requirements as specified in SECTION 01 78 23 and SECTION 01 32 16 (.01 or .02).
- E. Shipment requirements for spare parts as specified in SECTION 01 60 00.

1.4 QUALITY ASSURANCE
- A. Drainage piping specialties shall bear the label, stamp, or other markings of the specified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING
- A. As specified in SECTION 01 60 00.

1.6 WARRANTY
- A. As specified in SECTION 01 60 00.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Metal Roof Drains:
  1. CI, large sump, general purpose roof drains:
     a. Josam Company
     b. Marathon Roofing Products
     c. MIFAB, Inc.
     d. Smith, Jay R. Mfg. Co.
     e. Tyler Pipe
     f. Watts Water Technologies, Inc.
     g. Zurn Plumbing Products Group; Specification Drainage Operation
- B. Cleanouts:
  1. Floor cleanouts:
     a. Josam Company
     b. Oatey
     c. Sioux Chief Manufacturing Company, Inc.
     d. Smith, Jay R. Mfg. Co.
     e. Tyler Pipe
     f. Watts Water Technologies, Inc.
     g. Zurn Plumbing Products Group; Light Commercial Products Operation
     h. Zurn Plumbing Products Group; Specification Drainage Operation
  2. Test tees:
     a. Josam Company
     b. MIFAB, Inc.
     c. Smith, Jay R. Mfg. Co.
     d. Tyler Pipe
     e. Watts Water Technologies, Inc.
     f. Zurn Plumbing Products Group; Specification Drainage Operation

3. Wall cleanouts:
    a. Josam Company
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.
    d. Tyler Pipe
    e. Watts Water Technologies, Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation
4. Plastic floor cleanouts:
    a. Canplas LLC
    b. IPS Corporation
    c. NDS Inc.
    d. Plastic Oddities; a division of Diverse Corporate Technologies
    e. Sioux Chief Manufacturing Company, Inc.
    f. Zurn Plumbing Products Group; Light Commercial Products Operation

C. Backwater Valves:
1. Plastic, horizontal backwater valves:
    a. Canplas LLC
    b. IPS Corporation
    c. NDS Inc.
    d. Oatey
    e. Plastic Oddities; a division of Diverse Corporate Technologies
    f. Sioux Chief Manufacturing Company, Inc.
    g. Zurn Plumbing Products Group; Light Commercial Products Operation

D. Trench Drains:
1. Trench drains:
    a. Josam Company
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.
    d. Tyler Pipe
    e. Watts Water Technologies, Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation

E. Through-Penetration Firestop Assemblies:
1. ProSet Systems Inc.

2.2 COMPONENTS

A. Metal Roof Drains:
1. CI, large sump, general purpose roof drains:
    a. In accordance with ASME A112.6.4, for general purpose roof drains.
    b. Body material: CI.
    c. Combination flashing ring and gravel stop: Required.
    d. Flow control weirs: Required.
    e. Outlet: Bottom.
    f. Extension collars: Required.
    g. Underdeck clamp: Required.
    h. Expansion joint: Not required.
    i. Dome material: CI.
    j. Perforated gravel guard: SST.
    k. Vandal-proof dome: Not required.
    l. Water dam: 2 inches.

B. Miscellaneous Storm Drainage Piping Specialties:
1. Conductor nozzles:
    a. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
    b. Size: Same as connected conductor.

C. Cleanouts:
1. Test tees:
    a. In accordance with ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
    b. Size: Same as connected drainage piping.
    c. Body material: Hub and spigot, CI soil pipe T-branch or hubless, CI soil pipe test tee as required to match connected piping.
    d. Closure plug: Raised head, brass.
    e. Closure plug size: Same as or not more than one size smaller than the cleanout size.
2. Wall cleanouts:
    a. In accordance with ASME A112.36.2M, for cleanouts. Include wall access.
    b. Size: Same as connected drainage piping.
    c. Body material: Hubless, CI soil pipe test tee as required to match connected piping.
    d. Closure: Countersunk or raised headbrass plug.
    e. Closure plug size: Same as or not more than one size smaller than the cleanout size.
    f. Wall access: Round, flat, chrome-plated brass or SST cover plate with screw.

3. Plastic floor cleanouts:
    a. Size: Same as connected branch.
    b. Body material: PVC.
    c. Closure plug: PVC.
    d. Riser: Drainage pipe fitting and riser to the cleanout shall be of the same material as drainage piping.

D. Backwater Valves:
1. Plastic, horizontal backwater valves:
    a. In accordance with ASME A112.14.1, for backwater valves.
    b. Size: Same as connected piping.
    c. Body material: PVC.
    d. Cover: Same material as body with threaded access to check valve.
    e. Check valve: Removable swing check.
    f. End connections: Socket type.

E. Channel Drainage Systems:
1. Narrow, sloped invert, polymer concrete, channel drainage systems:
    a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
        1) Channel sections: Narrow, interlocking joint, sloped invert, polymer concrete modular units with end caps. Include rounded bottom, with built in invert slope of 0.6% and with outlets in number, sizes, and locations as shown on the Drawings. Include extension sections necessary for required depth.
            a) Dimensions: 4 inches inside width. Include the number of units required to form total lengths as shown on the Drawings.
            b) Frame: Galvanized steel or gray iron for grates.
        2) Grates: The Manufacturer's designation as heavy duty, with slots or perforations, and of the width and thickness that fit recesses in channel sections.
            a) Material: SST.
            b) Locking mechanism: The Manufacturer's standard device for securing grates to channel sections.
        3) Supports, anchors, and setting devices: The Manufacturer's standard unless otherwise shown on the Drawings.
        4) Channel section joining and fastening materials: As recommended by the System Manufacturer.

F. Through Penetration Firestop Assemblies:
1. In accordance with ASTM E 814, for through penetration firestop assemblies.
2. Certification and listing: Intertek Testing Service NA for through penetration firestop assemblies.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack fitting: In accordance with ASTM A 48, gray iron, hubless pattern, wye branch with neoprene O-ring at base and gray iron plug in thermal release harness. Include PVC protective cap for plug.
6. Special coating: Corrosion-resistant on interior of fittings.

G. Flashing Materials:
1. Copper sheet: In accordance with ASTM B 152, 12 oz/sf.
2. Zinc-coated steel sheet: In accordance with ASTM A 653, with 0.20% copper content and 0.04 inches minimum thickness unless otherwise shown on the Drawings. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if shown on the Drawings.
3. Elastic membrane sheet: In accordance with ASTM D 4068, flexible, chlorinated PE, 40 mil minimum thickness.
4. Fasteners: Metal compatible with material and substrate being fastened.
5. Metal accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
6. Solder: In accordance with ASTM B 32, lead free alloy.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas in accordance with the Roof Membrane Manufacturer's installation instructions.
1. Install the flashing collar or flange of roof drain to prevent leakage between the drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if shown on the Drawings, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install conductor nozzles at the exposed bottom of conductors where they spill onto grade.

C. Install cleanouts in above ground piping and building drain piping in accordance with the following instructions:
1. Use cleanouts the same size as drainage piping up to nominal pipe size 4. Use nominal pipe size 4 for larger drainage piping unless a larger cleanout is shown on the Drawings.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping nominal pipe size 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at the base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with the top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of the types shown on the Drawings, with the frame and cover flush with finished wall.
F. Install test tees in vertical conductors and near floor.
G. Install wall cleanouts in vertical conductors. Install an access door in the wall if shown on the Drawings.
H. Assemble channel drainage system components in accordance with the Manufacturer's instructions. Install on support devices so the top will be flush with adjacent surface.
I. Install through penetration firestop assemblies in plastic conductors at concrete floor penetrations.
J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.
K. Connections: In accordance with requirements for piping as specified in SECTION 22 14 00. Drawings indicate general arrangement of piping, fittings, and specialties.
L. Flashing Installation:
    1. Fabricate flashing from a single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing in accordance with the following if required:
        a. Lead sheets: Burn joints of 6.0 lb/sf lead sheets, 0.0938 inch thickness or thicker. Solder joints of 4.0 lb/sf lead sheets, 0.0625 inch thickness or thinner.
        b. Copper sheets: Solder joints of copper sheets.
    2. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
        a. Pipe flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
        b. Sleeve flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
        c. Embedded specialty flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
    3. Set flashing on floors and roofs in solid coating of bituminous cement.
    4. Secure flashing into sleeve and specialty clamping ring or device.
    5. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.2 PROTECTION

A. Protect drains during the remainder of the construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction Work.
B. Place plugs in the ends of uncompleted piping at the end of each day and when Work stops.

END OF SECTION

SECTION 22 14 29
SUMP PUMPS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for sump pumps.
- B. Related Sections:
  1. SECTION 01 60 00 – MATERIAL AND EQUIPMENT
  2. SECTION 03 30 00 – CAST-IN-PLACE CONCRETE
  3. SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING
  4. SECTION 22 14 00 – STORM DRAINAGE PIPING
  5. SECTION 26 05 19 – LOW-VOLTAGE CONDUCTORS
  6. SECTION 26 05 26 – GROUNDING AND BONDING
  7. SECTION 31 23 16 – EXCAVATION

1.2 REFERENCES
- A. American National Standards Institute/Hydraulic Institute (ANSI/HI):
  1. 1.1-1.2 – Rotodynamic Centrifugal Pumps for Nomenclature and Definitions
  2. 1.3 – Rotodynamic (Centrifugal) Pumps for Design and Application
  3. 1.4 – Rotodynamic (Centrifugal) Pumps for Manuals Describing Installation, Operation, and Maintenance
- B. National Electric Manufacturers Association (NEMA):
  1. 250 – Enclosures for Electrical Equipment
- C. National Fire Protection Agency (NFPA):
  1. 70 – National Electric Code (NEC)
- D. Underwriter's Laboratory (UL):
  1. 778 – Standard for Motor-Operated Water Pumps

1.3 COORDINATION
- A. Coordinate the size and location of concrete bases and pits. Concrete, reinforcement, and formwork requirements shall be as specified in SECTION 03 30 00.

1.4 SUBMITTALS
- A. Shop Drawings:
  1. Product data for each type of product indicated in this Section. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.
  2. Wiring diagrams for power, signal, and control wiring.
- B. Closeout Submittals:
  1. O&M data for pumps and controls, to include in O&M manuals.

1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, ARTICLE 100, by a testing agency acceptable to the AHJ, and marked for use in the intended location and application.
- B. UL Compliance: Motor-operated water pumps in accordance with UL 778.

1.6 DELIVERY, STORAGE, AND HANDLING
- A. As specified in SECTION 01 60 00. Specific requirements in addition to SECTION 01 60 00 shall be as follows:
  1. Retain shipping flange protective covers and protective coatings during storage.
  2. Protect bearings and couplings against damage.
  3. Comply with the Pump Manufacturer's rigging instructions for handling.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Submersible, Fixed Position, Single-Seal Sump Pumps:
  1. Bell & Gossett Domestic Pump, ITT Corporation
  2. Goulds Pumps, ITT Corporation
  3. Grundfos Pumps Corp.
  4. Little Giant Pump Co.
  5. Weil Pump Company, Inc.

2.2 OPERATION
- A. Sump Pump Capacities and Characteristics:
  1. Refer to equipment schedule as shown on the Drawings.

2.3 COMPONENTS
- A. Submersible, Fixed Position, Single-Seal Sump Pumps:
  1. Description: Factory-assembled and tested, simplex or duplex (as shown on the Drawings), single-stage, centrifugal, end suction, submersible, direct connected sump pumps complying with UL 778 and ANSI/HI 1.1-1.2 and ANSI/HI 1.3 for submersible sump pumps.
  2. Factory-assembled and tested sump pump unit.
  3. Pump type: Submersible, end suction, single-stage, close coupled, overhung impeller, centrifugal sump pump.
  4. Pump casing: SST; with SST inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange suitable for piping connection.
  5. Impeller: Statically and dynamically balanced, SST design for clear wastewater handling, and keyed and secured to shaft.
  6. Pump and motor shaft: SST, with factory-sealed, grease lubricated ball bearings.
  7. Seal: Mechanical.

8. Motor: Hermetically sealed, capacitor start type, with built-in overload protection; lifting eye or lug, three-conductor waterproof power cable of the length required, and with grounding plug and cable sealing assembly for connection at pump.
9. Controls: Simplex or duplex, as shown on the Drawings.
    a. Enclosure: In accordance with NEMA 250, Type 12.
    b. Switch type: Pedestal-mounted float switch; with float, float rod, and rod buttons. Non-mercury level switches for on, off, and alarm status.
    c. Automatic alternator: For duplex pumps, include an automatic alternator to alternate operation of pump units on successive cycles and to operate multiple units if one pump cannot handle the load.
    d. Float guides: Pipe or other restraint for floats and rods in basins of depth greater than 48 inches.
10. Control interface features:
    a. Remote alarm contacts: For remote alarm interface.
    b. Programmable logic controller: Auxiliary contacts rated 5 A at 120 VAC in pump controls for interface to building automation system and capable of providing the following:
        1) On-off status of pump.
        2) Alarm status.

B. Motors: In accordance with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
1. Motor sizes: Minimum size as shown on the Drawings. If not shown on the Drawings, large enough so driven load will not require motor to operate in SF range above 1.0.
2. Motors for submersible pumps shall be hermetically sealed.

C. Sump Pump Basins (Round Installations):
1. Description: Factory fabricated basin with sump, pipe connections, and separate cover.
2. Sump: Fabricate watertight, with sidewall openings for pipe connections.
    a. Material: CI or fiberglass.
    b. Reinforcement: Mounting plates for pumps, fittings, and accessories.
    c. Anchor flange: Same material as or compatible with sump, cast in or attached to sump, in the location and of the size required to anchor basin in concrete slab.

D. Cover: Fabricate with openings having gaskets, seals, and bushings, for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Material: CI or steel with bituminous coating.
2. Reinforcement: Steel or CI, capable of supporting foot traffic for basins installed in foot traffic areas.

E. Sump Pump Pits:
1. Description: Concrete pit with sump, pipe connections, curb frame, and separate cover.
2. Sump: Construct of watertight, cast-in-place, reinforced concrete with sidewall openings for pipe connections. Cast-in-place concrete, formwork, and reinforcement shall be as specified in SECTION 03 30 00.
    a. Pipe connections: Sleeved openings large enough for mechanical sleeve seals for drainage piping. Sleeves and mechanical sleeve seals shall be as specified in SECTION 22 05 00 and drainage piping shall be as specified in SECTION 22 14 00.

F. Curb Frame and Cover:
1. Curb frame material: Galvanized steel or steel with bituminous coating.
    a. Pattern: Z-cross-section shape with raised outer rim of height matching cover, for recessed mounting having installed cover flush with top of floor slab.
2. Cover: Fabricate with openings having gaskets, seals, and bushings, for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
    a. Material: CI or steel with bituminous coating.
    b. Reinforcement: Steel or CI, capable of supporting foot traffic for pits installed in foot traffic areas.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 INSTALLATION

A. Concrete:
1. If applicable, install concrete bases of dimensions shown on the Drawings for pumps and controllers. Refer to SECTION 22 05 00.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise shown on the Drawings, install dowel rods on 18 inch centers around full perimeter of base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting Drawings, templates, diagrams, instructions, and directions furnished with the items to be embedded.
5. Install anchor bolts to the elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements shall be as specified in SECTION 03 30 00.

C. Excavating, trenching, and backfilling shall be as specified in SECTION 31 23 16.

D. Pump Installation Standards:
1. Comply with the Manufacturer's guidelines for the installation of sump pumps.
2. Install sump pumps in accordance with requirements in ANSI/HI 1.4.

E. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.
   1. Install piping adjacent to equipment to allow service and maintenance.
F. Install packaged, pedestal, drainage pump units and make direct connection to storm drainage piping.
G. Install packaged, submersible, drainage pump unit basins on floor or concrete base unless recessed installation is shown on the Drawings. Make direct connections to storm drainage piping.
H. Support piping to ensure the weight of piping is not supported by pumps.
I. Connections:
   1. Piping installation requirements shall be as specified in SECTION 22 14 00. Drawings indicate the general arrangement of piping, fittings, and specialties.
   2. Install piping adjacent to sump pumps to allow service and maintenance.
   3. Connect storm drainage piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Refer to SECTION 22 14 00.
   4. Install flexible connectors adjacent to pumps in discharge piping.
   5. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves the same size as connected piping.
   6. Ground equipment shall be as specified in SECTION 26 05 26.
   7. Connect wiring shall be as specified in SECTION 26 05 19.

3.3 QUALITY CONTROL

A. ORT Prerequisite Activities: The following specified activities shall generally conclude with acceptance of the certificate of proper installation by the OWNER. Compliance with these requirements shall be the sole responsibility of the CONTRACTOR. Any modifications, retesting or additional expense resulting from the failure to pass these testing requirements on the initial tests, including costs incurred by the OWNER and the ENGINEER, shall be paid by the CONTRACTOR.
B. Field Quality Control:
   1. Manufacturer's field service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
   2. Perform tests and inspections:
      a. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
C. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Pumps and controls will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

3.4 STARTUP

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks in accordance with the Manufacturer's instructions.
   2. Verify bearing lubrication.
   3. Disconnect couplings and check motors for proper direction of rotation.
   4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate it until the cause of trouble is determined and corrected.
   5. Verify that pump controls are correct for required application.
B. Start pumps without exceeding safe motor power:
   1. Start motors.
   2. Open discharge valves slowly.
   3. Check general mechanical operation of pumps and motors.
C. Test and adjust controls and safeties.
D. Remove and replace damaged and malfunctioning components.
   1. Pump controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
   2. Set field adjustable switches and circuit breaker trip ranges as shown on the Drawings, or if not shown, for normal operation.
E. Engage a factory-authorized service representative to train the OWNER's maintenance personnel to adjust, operate, and maintain controls and pumps.

3.5 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by the Manufacturer.
B. Adjust control SPs.

END OF SECTION

INTENTIONALLY BLANK

SECTION 22 15 19
GENERAL SERVICE PACKAGE RECIPROCATING AIR COMPRESSORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general information, products, and execution for general service package reciprocating air compressors.

B. Related Sections:

1. SECTION 01 43 33 – MANUFACTURER'S SERVICES
2. SECTION 01 91 00 (.01 or .02) – COMMISSIONING
3. SECTION 09 90 00 – PAINTING AND COATING
4. SECTION 26 70 00 – MOTORS
5. SECTION 40 50 00 – INSTRUMENTATION AND CONTROL SYSTEMS

1.2 REFERENCES

A. International Organization for Standardization (ISO):

1. 9001 – Quality Management Systems – Requirements

B. National Electrical Manufacturers Association (NEMA):

1. MG 1 – Motors and Generators

1.3 DEFINITIONS

A. Standard Cubic FPM: Volume flow rate of air at standard conditions of 60°F, 14.7 psi absolute, and 36% relative humidity.

1.4 SUBMITTALS

A. Shop Drawings:

1. Make, model, weight, and hp of each equipment assembly.
2. Manufacturer's catalog information, descriptive literature, and specifications.
3. Complete Bill of Material for components.
4. Detailed mechanical and electrical drawings showing equipment fabrications. Include dimensions, size, and locations of connections to other work.
5. External utility requirements such as air, water, power, and drain for each component.
6. Functional description of internal and external I&C including list of parameters monitored, controlled, or alarmed.
7. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
8. Manufacturer's diagrams for air compressor piping.
9. Power and control wiring diagrams, including terminals and numbers:
    a. Terminal designations and numbers.
    b. Motor and electrical component cut sheets, Manufacturers, with model numbers, options and accessories identified.
    c. Motor full load amperes.
    d. Complete motor nameplate information, including nameplate information in accordance with NEMA MG 1.
    e. Electric solenoid Manufacturer, voltage, wattage, catalog number, flow efficient (Cv) value for air, etc.
    f. Detailed power and control wiring diagrams, including numbered terminals, complete control schematics including equipment, devices, variable speed drives, etc.
    g. Detailed electrical drawings showing the equipment dimensions, size, and locations of connections for equipment.
    h. Complete motor information including, but not limited to:
        1) Motor:
            a) Manufacturer's name and date manufactured.
            b) Model number.
            c) Serial number.
            d) Descriptive information.
            e) Nameplate data in accordance with NEMA MG 1 and include any motor modifications.
            f) Dimensional drawings of the equipment.
            g) Motor bearing life documentation.
            h) Additional rating information.
                (1) sf.
                (2) Locked rotor current.
                (3) No load current.
                (4) Inverter rated documentation.
                (5) Efficiency.
                (6) For motors 5 hp and larger provide: Factory performance data curves showing speed, slip, torque, current, kW input, power factor and percent efficiency.
                (7) For motors 5 hp and larger provide: X/R ratio, reactances, resistances, short circuit time constants, open circuit time constants, rotor inertia, etc.
            i) Enclosure type.
            j) Dimensions and total weight.
            k) Bearing type.
            l) Description and rating of motor thermal protection.

m) hp derating calculations.

B. Quality Control Submittals:
1. Manufacturer's recommended vibration limits of compressed air system.
2. Field performance test procedures.
3. Manufacturer's instructions:
a. Installation of equipment.
b. Installation of vibration isolators.
4. Factory test reports of each test and inspection.
5. Field test reports for each functional and performance test of equipment.
6. Manufacturer's certificate of compliance.
7. Manufacturer's certificate of proper installation for equipment.
8. O&M manuals:
a. Legends abbreviation lists.
b. Bill of Materials.
c. Catalog cuts.
d. Component data sheets.
e. Final As-Built Drawings and wiring diagrams shall be provided in hardcopy and DWG formats. Photos shall be individually labeled with descriptions and dates and shall be in JPG format.
1) Use the DW approved dropbox for Drawings. AutoCAD Drawings shall be in accordance with DW Design Drafting Standards and shall include, but not be limited to, the Standards located online in DW's CPPM: https://www.denverwater.org/contractors/construction-information/design-standards/cad-standards.
f. Factory and field certified test reports.
g. Device O&M manuals for components, electrical devices, and mechanical devices shall include:
1) Operations procedures.
2) Installation requirements and procedures.
3) Maintenance requirements and procedures.
4) Troubleshooting procedures.
5) Internal schematic and wiring diagrams.
h. List of spares and expendables required and recommended.
i. Manufacturer's certificate of warranty.

C. Warranty:
1. Sample warranty.
2. Warranty.

D. Supplements listed in this Section.

1.5 QUALITY ASSURANCE

A. Equipment Manufacturer: A minimum of 5 years of documented experience in the Work of this Section.

B. UL Compliance: Materials manufactured within scope of UL shall conform to UL standards and have an applied UL listing mark.

C. The Manufacturer shall provide a certificate of ISO 9001 compliance.

1.6 SITE CONDITIONS

A. Materials and equipment shall be designed and constructed for continuous operation, at rated current and voltage, at 5,500 feet above mean sea level, 140°F ambient and 95% relative humidity.

1.7 WARRANTY

A. Warranty for 5 years from the Substantial Completion date for the satisfactory performance and installation of the compressed air equipment and associated appurtenances.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Tank Mounted Air Compressors:
1. Gardner Denver
2. Quincy
3. Champion

B. Flexible Discharge Connection:
1. Thermo Tech, FFC

C. Discharge Air Filters:
1. General purpose filter for liquid and solid particle removal down to 1 micron.
a. Champion, Model CFL 14C13EP, with EDDS1 auto electric drain
2. High efficiency oil removal capable of handling liquid loads up to 100 ppm weight/weight, provides 0.0008 ppm aerosol removal, and solid removal of 0.01 micron
a. Champion, Model CFL 14F13EP, with EDDS1 auto electric drain

D. Release Air Muffler:
1. Allied Wilton Co., Model R07, Part #0412007

E. Automatic Drain Valve:
1. Gardner Denver, EDDS1 Series

F. Service Filters:
1. Separator/filter:
a. Champion, Denver, Model CFL 26C23AG

2. Efficiency oil removal filter:
    a. Champion, Model CFL 26F23AG

2.2 MATERIALS

A. Equipment:

1. General:
    a. Furnish air compressor as a complete system that includes compressor, motor, controls, and accessories.
    b. Reference the Equipment Schedule on the Drawings for the air compressor rating and other pertinent information.
2. Base or tank mounted air compressor:
    a. Single-stage reciprocating compressor pump.
    b. Pressure lubricating system, CI cylinders.
    c. Air-cooled.
    d. Operating discharge pressure: 175 psig.
    e. High temperature switch.
    f. Low oil level switch.
    g. Low oil pressure shutdown switch.
    h. Equip with combination air intake filter silencer.
    i. 0 psi to 200 psi liquid filled pressure gauge for tank and discharge air piping after regulator.
    j. Automatic unloading during startup.
    k. Mount motor and compressor on common steel base attached to receiver.
    l. Compressor connected to motor by V-belt drive system with guard, and convenient method of belt tensioning.
    m. Capable of operating continuously at 95°F at specified output without overheating.
    n. Adjustable control pressure: 125 psig to start and 175 psig to stop for compressor.
    o. Motor: Refer to the Induction Motor Data Sheet.
    p. Receiver if shown on the Equipment Schedule:
        1) Vertical welded steel receiver bearing ASME code stamp and with inspection openings.
        2) Maximum allowable working pressure: 200 psig.
        3) Safety relief valve set for 200 psig.
        4) Pressure gauge with gauge cock.
        5) Automatic condensate drain valve with isolation valve.
        6) Manual blowdown valve located at low point in receiver.
        7) Vibration isolation pads under mounting feet.
    q. Aftercooler if shown on the Equipment Schedule:
        1) Compressor mounted.
        2) Air to air heat exchanger.
        3) Capacity to match air compressor.
        4) Locate moisture separator downstream of after-cooler and include automatically trapped drain.
3. Electrical, I&C:
    a. The Electrical Drawings and the following sections expand on the electrical, I&C requirements of the compressed air system and this Section. Motors shall be as specified in SECTION 26 70 00.
    b. Provide the functions and components necessary for a complete, operational system of controls that provide the specified performance and functionality, in accordance with the Contract Documents and as recommended by the Manufacturer. Provide items of an incidental nature which may be necessary for proper system operation and performance.
    c. Alarms and control instruments: The following devices shall be provided as a minimum and mounted on the air compressor skid as listed herein. The devices shall be suitable to interface and perform the indicated function directly or through auxiliary devices as shown on the E and EI Drawings and as specified in SECTION 40 50 00.
        1) TS1 – High air temperature shutdown.
        2) PS1 – High pressure shutdown.
        3) LS1 – Low oil level.
        4) Low oil pressure alarm.
        5) Auto drain alarms.
        6) Air compressor operational control.
    d. The air compressor shall be provided with power and controls necessary to interface electrical equipment as shown on the E and EI Drawings. The interface shall be performed by the Division 26 Electrical Contractor and the Division 40 I&C Systems Integrator.
4. Lifting lugs: Provide suitably attached for equipment assemblies and components weighing over 100 lbs.
5. Equipment identification plates: Provide 16 gauge SST identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 1/4 inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.
6. Anchor bolts: Galvanized, 1/2 inch minimum diameter.

2.3 ACCESSORIES

A. Discharge filters:

1. General purpose filter for liquid and solid particle removal down to 1 micron. Install on discharge piping from air compressor prior to high efficiency oil removal filter.

2. High efficiency oil removal capable of handling liquid loads up to 100 ppm weight/weight, provides 0.0008 ppm aerosol removal, and solid removal of 0.01 micron.
3. Separator/filter for liquid and sold particle removal down to 3 micron solid particulates, 5 ppm weight/weight oil removal, and liquid load up to 25,000 ppm weight/weight.
4. Efficient oil removal filter for liquid and solid particle removal down to 0.01 micron solid particulates, 0.008 ppm weight/weight oil removal, and liquid load up to 1,000 ppm weight/weight.

B. Safety Valve:
1. Fabrication: Bronze body, bronze base, disc with steel spring, top outlet, and malleable iron lifting lever.
2. In accordance with ASME Code for Unfired Pressure Vessels.
3. Set to relieve at 200 psig and relieve full compressor capacity.

C. Automatic Drain Valve:
1. Located on receiver tank, and filters.
2. Electronic drain, manual blow down valve, strainer ball valve.
3. Automatic operation 115 V electrical requirement.
4. Working Pressure: 200 psig.

D. Flexible Discharge Connection:
1. Bronze corrugated hose and wire braid.
2. Female copper sweat ends.
3. 10 inches overall length.
4. 440 psi: Working pressure.

E. Anti-vibration Mounts:
1. Included in the package to reduce or eliminate vibration.
2. Manufacturer sized and designed.

2.4 FINISHES

A. Prepare, prime, and finish coat as specified in SECTION 09 90 00, system number 106 and color code section.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install equipment on vibration isolators in accordance with the Manufacturer's instructions.
1. Piping: Equip with full-size flexible discharge connection, check valve, and isolation valve.

B. Air Compressor Piping:
1. Install in accordance with the Manufacturer's piping diagrams.
2. Pipe tank drain, and auto air filter drains to hub drain.

C. Manufacturer's Services: Provide a Manufacturer’s representative as specified in SECTION 01 43 33 for installation assistance, inspection, certification of proper installation, startup assistance, and training of the OWNER’s personnel for specified equipment.

3.2 STARTUP

A. Equipment commissioning and testing shall be as specified in SECTION 01 91 00 and in accordance with the Manufacturer’s instructions.

3.3 QUALITY CONTROL

A. Factory Inspections: Inspect equipment for required construction, electrical connection, and intended function.

B. Functional Tests: Conduct on each piece of equipment in the system prior to testing compressed air system as a whole.

END OF SECTION

SECTION 22 45 13
EMERGENCY SHOWERS

PART 1 GENERAL

1.1 SUMMARY
- A. Section includes general information, products, and execution for emergency showers.

1.2 REFERENCES
- A. American National Standards Institute/International Safety Equipment Association (ANSI/ISEA):
  1. Z358.1 – American National Standard for Emergency Eyewash and Shower Equipment

1.3 SUBMITTALS
- A. Product Data: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.4 QUALITY ASSURANCE
- A. Regulatory Requirements: In accordance with ADA and local and state requirements.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS
- A. Emergency Showers and Eye/Face Washes:
  1. Bradley Corporation
  2. Guardian Equipment
  3. Haws Corporation
  4. Speakman Company
  5. Western Safety Products
- B. Tube Type Water Gauge:
  1. Haws Drinking Faucet Co., Model 9010

2.2 MATERIALS
- A. Safety equipment shall be in accordance with ANSI/ISEA Z358.1.
- B. Combination SSH:
  1. Pipe and fittings: Schedule 80 PVC with factory-applied, corrosion-resistant coating.
  2. Showerhead and eye/face wash bowl: Yellow, impact-resistant plastic.
  3. Valves: Stay-open ball valves; shower valve, chrome-plated brass 1 inch NPT; eye/face wash valve, chrome-plated brass 1/2 inch NPT.
  4. Supply: 1 1/4 inch NPT female top or side inlet.
  5. Flow control: Provide showerhead and eye/face wash with integral self-regulating flow control to allow both parts of the emergency equipment to be used simultaneously.
  6. Alarm: Provide a remote flow switch alarm on each combination safety shower.
  7. Sign: Furnish each unit with an ANSI/ISEA-compliant identification sign.
- C. SSH, Barrier-Free Combination:
  1. Pipe and fittings: Schedule 80 PVC with factory-applied, corrosion-resistant coating.
  2. Showerhead and eye/face wash bowl: Yellow, impact-resistant plastic.
  3. Valves: Stay-open ball valves; shower valve, chrome-plated brass 1 inch NPT; eye/face wash valve, chrome-plated brass 1/2 inch NPT.
  4. Supply: 1 1/4 inch NPT female top or side inlet.
  5. Flow control: Provide showerhead and eye/face wash with integral self-regulating flow control to allow both parts of the emergency equipment to be used simultaneously.
  6. Alarm: Provide a remote flow switch alarm on each combination safety shower.
  7. The unit shall be in accordance with ADA requirements.
  8. Sign: Furnish each unit with an ANSI-compliant identification sign.
- D. SSH, Combination, Exterior:
  1. Pipe and fittings: Schedule 40 SST.
  2. Showerhead: Yellow, impact-resistant plastic.
  3. Valves: Stay-open ball valves; shower valve, chrome-plated brass 1 inch NPT; eye/face wash valve, chrome-plated brass 1/2 inch NPT; water supply freeze protection valve 1 1/4 inch NPT.
  4. Supply: 1 1/4 inch NPT top supply.
  5. Flow control: Provide showerhead and eye/face wash with integral self-regulating flow control to allow both parts of the emergency equipment to be used simultaneously.
  6. Alarm: Provide a remote flow switch alarm on each combination SSH.
  7. Heat trace: Provide self-regulated heat trace cable rated at 5 W/ft, regulated to -50°F, 120 V service and temperature control thermostat.
  8. Insulation: Provide 3/4 inch PE pipe insulation.
  9. Shell: Safety yellow, removable plastic cover for SSH unit; ABS plastic with flexible vinyl trim.
  10. Junction box: Aluminum junction box with multiple hubs that accepts 3/4 inch IPS conduit.
  11. Sign: Furnish each unit with an ANSI-compliant identification sign.

PART 3 EXECUTION

3.1 GENERAL
- A. Drawings do not show exact details of fixtures.
- B. Extra compensation will not be allowed for obstruction caused by the Work of other trades or local obstructions to Work as specified in this Section that require offsets.
- C. The preparation of structural components required for fixtures, equipment, and material to be installed as specified in this Section shall be performed by the particular affected trade.

D. Where diagrams show fixture locations, the CONTRACTOR is cautioned that diagrams shall not be used for obtaining material quantities.
E. Changes in the locations of fixtures, if advisable in the opinion of the CONTRACTOR, shall be submitted to the ENGINEER for review before proceeding with the Work.

3.2 INSTALLATION

A. Safety Equipment:
1. System shutoff valves shall:
a. Give visual indication of position, open or closed.
b. Be lockable valves and locked in open position.
2. Each SSH, and combination safety shower shall have a red safety signoff tag. The CONTRACTOR and the OWNER shall sign the red safety signoff tag after:
a. Visually checking the safety eyewash piping for leaks.
b. Verifying that upon operation, stay-open valves remain open.

3.3 QUALITY CONTROL

A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.
B. Notify the ENGINEER 2 days prior to shower testing. The ENGINEER reserves the right to witness tempered water and safety shower testing.
C. Test safety shower and eye/face wash units. Water flow shall be tested at both showerhead and eyewash/face ring.
1. The minimum flow rate for eyewashes shall be 3 gpm.
2. The minimum flow rate for safety showers shall be 20 gpm.
3. Log, date, and initial the inspection upon successful flow tests.
D. Verify alarm operation both locally and system-wide. Notify the ENGINEER prior to testing if the alarm is connected system-wide.

END OF SECTION