Contract/Technical Specifications

for

Jordan Valley Water Treatment Plant
JVWTP Solids Collection Equipment Upgrade Project

Volume II of IV

PREPARED FOR

Jordan Valley Water Conservancy District
8215 S 1300 W
West Jordan, UT 84088

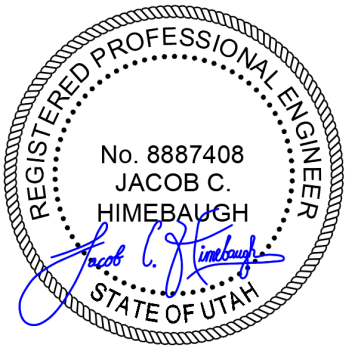
JVWCD Project No. 4277

JORDAN VALLEY WATER
CONSERVANCY DISTRICT

PREPARED BY

Brown and Caldwell
6975 Union Park Center, Suite 490
Salt Lake City, Utah 84047

BC Project No. 157012



THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

Technical Specifications
JVWTP Sedimentation Basin Equipment Upgrade Project
BC Project No. 157012

VOLUME I: CONTRACT DOCUMENTS

VOLUME II: TECHNICAL SPECIFICATIONS

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. The work covered under this contract will be performed at the site of the Jordan Valley Water Treatment Plant located at 15305 S 3200 W, Herriman, UT 84065.

B. The work shall consist of furnishing tools, equipment, materials, supplies and labor, transportation, and performing all work or other operations required for the fulfillment of the Contract in accordance with the Contract Documents.

C. The work shall be complete, and all work, materials, and services not expressly indicated or called out in the Contract Documents which may be necessary for the complete and proper construction of the work in good faith shall be provided at no increase in cost to the Owner.

1.02 DESCRIPTION OF OWNER'S PROJECT

A. The overall project will consist of the furnishing of all labor, materials, and equipment for the supply, delivery, fabrication, installation, testing and other materials and services required for the JVWTP Solids Collection Equipment Upgrade Project to replace all chain and flight mechanisms, install plate settler equipment, perform seismic upgrades in Basins 3, 4, 5, and 6, and all other supporting work shown and described in the Contract Documents. Specific features include, but are not limited to:

1. Demolition and disposal of 28 existing chain and flight mechanisms in Basins 3, 4, 5, and 6 including on-deck equipment (drive units, drive unit enclosures, etc.)
2. Demolition and disposal of existing cabling and wiring and on-deck junction boxes supporting existing chain and flight equipment in Basins 3, 4, 5 and 6.
3. Seismic upgrades in Basins 3, 4, 5 and 6 consisting of wall and slab strengthening for the interior dividing wall between Basins 3 and 4 as well as between Basins 5 and 6.
4. Seismic upgrades in Basin 3 and Basin 6 consisting of exterior wall strengthening on the North and South Wall, respectively.
5. Installation of 28 chain and flight mechanisms in Basins 3, 4, 5, and 6.
6. Installation of cabling and wiring and on-deck junction boxes supporting chain and flight equipment in Basins 3, 4, 5 and 6.
7. Demolition and disposal of lean concrete segments along the short walls running the length of each basin along with select wall corbels inside each basin to install plate settler support structure and chain and flight supports.
8. Installation of plate settler support structure and plate settler packs in Basins 3, 4, 5 and 6.
9. Installation of utility water hydrants around the perimeter of basins for washing down plate settler packs during operation including connection to the existing plant water running on the east side of the basins.
10. Installation of platforms and ladders to access the top of the plate settler packs and the basins for maintenance and inspection.

11. Coordination of testing and start up with Owner and Equipment Supplier.

B. Except as specifically noted otherwise, provide and pay for:
   1. Insurance and bonds
   2. Labor, material, and equipment
   3. Applicable sales tax
   4. Applicable construction permits
   5. Tools, equipment, and machinery required for construction
   6. Traffic control and dust control measures
   7. Other facilities and services necessary for proper execution and completion of the Work.

1.03 ELECTRICAL SUMMARY OF WORK

A. Existing Chain and Flight solids collection machinery, including motors, is being removed and replaced with new similar equipment in four sedimentation basins. Each basin has five sets of machinery, each with a motor, overtorque switches, shear pin switches, and a manual Lock Out Stop (LOS) switch. This equipment is located outdoors. Motors and associated shear pin and overtorque switches are furnished by the chain and flight equipment supplier.

B. Motor starters and controls are located inside of the treatment plant building in Motor Control Centers (MCCs) and Remote Terminal Units (RTUs). This equipment is to remain in place essentially unchanged.

C. Electrical power and control conductors between the outdoor equipment and indoor MCCs will be removed and replaced with all new conductors. Outdoor conductors are installed in PVC conduits which are concrete embedded in the north-south direction and are suspended under concrete decks in the east-west directions. Conductors route through some flush deck boxes. Some suspended conduits are broken and require repair. New conductors shall be installed continuous without splices.

D. Indoor conductors are installed in existing rigid steel conduits and steel wireways.

E. An aluminum channel instrument/control stand is located at each motor location. The stand supports a pull box, a convenience receptacle, and a Lock Out Stop (LOS) switch in a small stainless steel enclosure. The aluminum channel stand will remain in place. The pull box will be removed and replaced with a new stainless steel enclosure. The convenience receptacle and associated conductors will be removed and not replaced. The LOS enclosure will be temporarily removed, then re-installed. The LOS switch will be replaced with a new similar switch. The Contractor will furnish all new items at the instrument/control stand.

F. New conductors will be pulled into place and hipot tested before termination. After termination, electrical equipment will be operationally tested and adjusted as necessary.

1.04 ACTIVITIES BY OTHERS

A. Owner, utilities, and others may perform activities within the Project area while the Work is in progress.

1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

B. Activities by other which may affect performance of work include:
   1. Chemical deliveries
   2. Routine maintenance
   3. Continued operation of the water treatment plant

C. Cooperate with others to minimize inference and delays

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 CONTINUITY OF PLANT OPERATIONS

A. The Jordan Valley Water Treatment Plant will remain in operation during construction activities included in this Work. Function of the water treatment plant shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes.

1.02 COMPLIANCE WITH DRINKING WATER PERMIT

A. The existing facility operates under the terms of a permit issued by the Utah Division of Drinking Water. This permit specifies the water quality limits that the plant must meet prior to discharge of finished water. A copy of the existing permit is on file for review at the Utah Division of Drinking Water.

B. Contractor shall bear the cost of penalties imposed on the Owner for water quality violations caused by actions of the Contractor, including any and all costs to remedy the situation.

1.03 SUBMITTAL

A. In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for operations that make it necessary to remove a basin, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing an outage or other impact on associated treatment processes, the length of time required to complete said operation, the necessary plant modifications or restrictions, and associated equipment which the Contractor shall provide in order to prevent impacts on plant operations.

B. The Contractor shall observe the following restrictions:
   1. Basins, systems, or individual equipment items shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.
   2. The Construction Manager shall be notified in writing at least one week in advance of the planned operation.

1.04 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. General basin shutdown constraints: Comply with basin shutdown constraints described in general terms as identified in this section.
   1. Execute the Work during the scheduled basin shutdown.
   2. Constraints apply to activities of construction regardless of process or work area.

3. Activities that disrupt plant or utilities operations must comply with these basin shutdown constraints.
4. Provide thorough advanced planning, including pre-planning meetings with Construction Manager and having required equipment, materials, and labor on hand at time of basin shutdown.
5. Owner maintains the ability to abort on the day of a scheduled basin shutdown.

B. The following work sequences, arising from the need to maintain plant operations, have been identified by the Owner and Engineer and are presented for the benefit of the Contractor. The work sequences presented herein are not meant to be complete nor exhaustive but are intended to define basic project requirements upon which Contractor may develop overall project schedule.
   1. The JVWTP has six sedimentation basins, and all six must be online during summer months (May – September) to meet demand. Basins may be taken offline only during off-peak months between October and April. **A maximum of two basins may be offline at any given time.**
   2. **Milestone C1:** Repairs, Basins 1 and 2 (Available October 2022)
      a. Basin 1 shall be taken offline, isolated and dewatered by the owner prior to performing Work included in this Contract. Owner shall advise Contractor when Basins are ready for Work.
      b. Perform inspection of the circular mechanisms and basin as defined in the contract documents and drawings.
      c. Repair circular mechanisms and basin as defined in the contract documents and drawings.
      d. Upon completion of the Basin 1 Work, owner will refill and bring Basin 1 online.
      e. Follow same sequence as previously outlined for Basin 1 for Work in Basin 2.
      f. **Basins 1 and 2 shall be online and operable by May 1, 2023.**
   3. **Milestone C2:** Chain and Flight Installation, Basins 3 and 4 (Available November 2022)
      a. Upon Completion of Work in Basins 1 or 2, Basins 3 or 4 may be taken offline, isolated and dewatered by the Owner to performing Work included in this Contract. Owner will advise Contractor when a basin is available for Work.
      b. Perform demolition of seven existing chain and flight mechanisms in each offline basin including all components within the basin and mounted to the deck. Pull wiring and cabling for each unit back to Pull Box 214.
      c. Perform seismic work in Basin 4 as defined in the drawings.
      d. Install new chain and flight equipment, plate settler support columns, and appurtenances in accordance with the Manufacturer's instructions and drawings.
      e. Perform seismic work on the outside wall of Basin 3 as defined in the drawings.
      f. Install new electrical components (wiring, cabling, junction boxes, etc.) for Basin 3 and 4 in accordance with the Contract.
      g. Install utility water system including connection to the plant water outside of the basin for Basins 3 and 4 in accordance with the Contract.
      h. Upon completion of the Work, Owner will refill Basins 3 and 4 and bring basins online.
      i. **Basin 3 and 4 shall be online and operable by May 1, 2023.**

4. **Milestone C3:** Chain and Flight Installation, Basins 5 and 6 (Available November 2022)
    a. Upon Completion of Work in Basins 3 or 4, Basins 5 or 6 may be taken offline, isolated and dewatered by the Owner to performing Work included in this Contract. Owner will advise Contractor when a basin is available for Work.
    b. Perform demolition of seven existing chain and flight mechanisms in each offline basin including all components within the basin and mounted to the deck. Pull wiring and cabling for each unit back to Pull Box 214.
    c. Perform seismic work in Basin 5 as defined in the drawings.
    d. Install new chain and flight equipment, plate settler support columns, and appurtenances in accordance with the Manufacturer's instructions and drawings.
    e. Perform seismic work on the outside wall of Basin 3 as defined in the drawings.
    f. Install new electrical components (wiring, cabling, junction boxes, etc.) for Basin 5 and 6 in accordance with the Contract.
    g. Install utility water system including connection to the plant water outside of the basin for Basins 5 and 6 in accordance with the Contract.
    h. Upon completion of the Work, Owner will refill Basins 3 and 4 and bring basins online.
    i. Basin 5 and 6 shall be online and operable by May 1, 2023.
5. **Milestone C4:** Plate Pack Installation, Basins 3 and 4 (Available October 2023)
    a. Basins 3 or 4 will again be taken offline, isolated and dewatered by the Owner prior to performing Work included in this Contract. Owner will advise Contractor when Basins are ready for Work.
    b. Install plate settler equipment, maintenance platforms and ladders in Basins 3 and 4 in accordance with the contract documents and manufacturer's instructions and drawings.
    c. All basins shall be online and operable by May 1, 2024.
6. **Milestone C5:** Plate Pack Installation, Basins 5 and 6 (January 2024)
    a. If not already performed, Basins 5 and 6 will be taken offline, isolated and dewatered by the Owner prior to performing Work included in this Contract. Owner will advise Contractor when Basins are ready for work.
    b. Install plate settler equipment, maintenance platforms and ladders in Basins 5 and 6 in accordance with the contract documents and manufacturer's instructions and drawings.
    c. All basins shall be online and operable by May 1, 2024.

C. The construction schedule required in the General Conditions of the Contract shall provide for the following specific conditions:
    1. Mobilization. Preparatory work activities to be completed up-front and part of Contractor mobilization include, but are not limited to:
        a. Site preparation including field measurements and verification of the existing chain and flight equipment.
        b. Submittals
        c. Placement of Contractor's materials and amenities.
    2. Demolition of chain and flight equipment and electrical cabling and wiring

a. Contractor shall prepare a demolition plan, submit to and coordinate with the Construction Manager before starting any demolition activities. Demolition plan shall include provisions to expose, handle, and dispose of any hazardous materials.

3. Replacement of all chain and flight equipment in Basins 3 through 6 and appurtenances.

D. The Plan shall be coordinated with the Contractor's Construction schedule and meet the restrictions and conditions specified in the Contract Documents.

E. The Plan shall describe the Contractor's means and methods for performing the tasks listed above and the length of time required to complete said tasks.

END OF SECTION

SECTION 01 21 00

ALLOWANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Listing of allowance items:
      a. Related responsibilities of ENGINEER and CONTRACTOR, and procedures.

1.02 ALLOWANCE AMOUNTS

A. Include following amounts in Contract Price for furnishing products and labor:
   1. $20,000 for concrete repair work in Basin 1 through 6 not identified in the Contract Documents.
      a. After removal of the existing chain and flight equipment, the Construction Manager will inspect the basin, identifying areas needing grinding, patching or other minor repair work.
      b. Contractor shall establish an hourly rate based on a two-man crew to perform the minor repair work and provide a unit price in the bid schedule.
      c. Perform concrete repair in accordance with Section 03 01 00.
   2. $30,000 for structural repairs defined on detail S-1001 on drawing S-01-002.
      a. The Construction Manager will inspect the joints after the Contractor removes the coating at the tie rod connections and the joint between the center structural cage and rake arm as discussed in drawings S-01-003, S-01-004 and S-01-005. Representative shall authorize Contractor to repair joints as required.
      b. Contractor shall establish a unit price for repair of one clarifier mechanism in accordance with detail S-1001 on drawing S-01-002 and shall include unit price in the bid schedule.

1.03 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

A. Costs included in allowances for furnishing products and labor:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes.
   4. Overhead and profit.

1.04 DUTIES OF CONTRACTOR IN PROVIDING PRODUCTS BY ALLOWANCE

A. Verify total cost with suppliers, including:
   1. Quantity.
   2. Complete description of product and services provided under allowance.
   3. Unit cost.
   4. Total amount of purchase.
   5. Taxes and delivery charges.
   6. Install cost.

1.05 ADJUSTMENT OF COSTS

A. When actual cost is more or less than amount of allowance, Contract Price will be adjusted by Change Order.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SCOPE

A. This section specifies the procedures for preparing and revising the critical path method construction schedule used for planning and managing construction activities. The schedule provides a basis for determining the progress status of the project relative to specific dates and completion time.

1.02 DESCRIPTION

A. The Contractor shall provide a graphic construction schedule prepared by the critical path method of analysis. The critical path schedule shall be prepared from estimates of the required duration and sequence for each item of work and function to be performed. A general guide for preparing such a schedule is contained in "The Use of CPM in Construction, A Manual for Contractors," published by the Associated General Contractors of America.

B. The schedule shall depict all significant construction activities and all items of work listed in the breakdown of contract prices submitted by the Contractor in accordance with the General Conditions of the Contract Documents. The dependencies between activities shall be indicated so that it may be established what effect the progress of any one activity has on the schedule.

C. Time for completion and all specific dates as specified in the Contract Documents and sequencing requirements described in Section 01 12 16 shall be shown on the schedule. Activities making up the critical path shall be identified.

D. No activity on the schedule shall have a duration longer than 21 days or assigned value greater than $100,000, except activities comprising off-site (material) fabrication, and delivery may extend for more than 21 days. Activities which exceed these limits shall be divided into more detailed components. The schedule duration of each activity shall be based on the work being performed during the normal 40-hour workweek with allowances made for legal holidays and normal weather conditions.

1.03 SUBMITTAL PROCEDURES

A. Within 20 days after the date of Notice to Proceed, the Contractor shall complete a construction schedule conforming to paragraph 1.02 Description and representing in detail all planned procurement and on-site construction activities. The schedule shall be prepared on reproducible paper and may be in draft form with legible freehand lines and lettering. Upon completion of the schedule, the Contractor shall submit a digital copy to the Construction Manager in accordance with Section 01 33 00.

B. Within 14 days after receipt of the submittal, the Construction Manager shall review the submitted schedule and return one copy of the marked-up original to the Contractor. If the Construction Manager finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy,

returned to the Contractor for corrections and resubmitted as specified in Section 01 33 00.

1.04 SCHEDULE REVISIONS

A. Revisions to the accepted critical path construction schedule may be made only with written approval of the Contractor and Owner. Changes in timing for activities which are not on the critical path may be modified with written agreement of the Contractor and Construction Manager. A change affecting the contract value of any activity, the timing of any activity on the critical path, the completion time and specific dates as specified in the Contract Documents, and work sequencing (Section 01 12 16) may be made only in accordance with applicable provisions of the General Conditions of the Contract Documents.

1.05 PROJECT STATUS UPDATE

A. Project status review and update shall be provided each month as specified in the General Conditions of the Contract Documents.

END OF SECTION

SECTION 01 32 23

SURVEY AND LAYOUT DATA

PART 1 GENERAL

1.01 SURVEY AND LAYOUT

A. The Owner will establish reference benchmarks and baselines as specified.

B. From the information provided, the Contractor shall develop and make such additional surveys as are needed for construction, such as control lines, slope stakes, batter boards, stakes for pipe locations and other working points, lines, and elevations.

C. Survey work shall be performed under the supervision of a licensed land surveyor or registered civil engineer. Contractor shall reestablish reference benchmarks and survey control monuments destroyed by his operations at no cost to the Owner.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 PRECONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide preconstruction photographs of the construction areas prior to commencement of work on the site. The photographs shall be digital format, and shall be provided with information to identify the location where the photograph. Preconstruction photographs shall be taken at locations to be designated by the Construction Manager.

1.02 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide construction photographs showing the progress of the work. The photographs shall be taken of such subjects as may be directed. The photographs shall be digital format, and shall be provided with information to identify the location where the photograph. Starting one month after the date of the preconstruction photographs and continuing as long as the work is in progress, monthly photographs shall be taken.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, requests for substitutions, and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, and piping and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the contract documents.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. General:

1. The Contractor shall be responsible for the accuracy and completeness of the information contained in each submittal and shall assure that the material, equipment or method of work shall be as described in the submittal. The Contractor shall verify that all features of all products conform to the specified requirements. Submittal documents shall be clearly edited to indicate only those items, models, or series of equipment, which are being submitted for review. All extraneous materials shall be crossed out or otherwise obliterated. The Contractor shall ensure that there is no conflict with other submittals. The Contractor shall coordinate submittals among his subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in paragraph 43 05 11-1.02 Unit Responsibility and applicable technical sections.
2. The Contractor shall coordinate submittals with the work to avoid delaying work. The Contractor shall coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals. The Contractor shall not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment shall be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
3. The Contractor shall certify on each submittal document that he has reviewed the submittal, verified field conditions, and complied with the contract documents.

B. Request for substitution--special equipment:

1. Requests for substitution for equipment specified by manufacturer or manufacturer's model number and listed below shall be in writing and shall be accompanied with sufficient information to permit the Construction Manager to identify the nature and scope of the request. Information to be provided along with the request for substitution shall include:

a. All submittal information required for the specified equipment, including all deviations from the specified requirements necessitated by the proposed substitution.
b. Materials of construction, including material specifications and references.
c. Performance data, including performance curves and guaranteed power consumption, over the range of specified operating conditions.
d. Dimensional drawings, showing required access and clearances, including any changes to the work required to accommodate the proposed substitution.
e. Where controls are a part of the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in the project format and with project-specific symbols, along with control descriptions.
f. Where controls specified in the project manual require modification to accommodate the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in project format and with project-specific symbols, with all required modifications clearly highlighted.
g. Information and performance characteristics for all system components and ancillary devices to be furnished as a part of the proposed substitution.
h. Reproducible contract drawings, marked up to illustrate the alterations to all structural, architectural, mechanical, electrical and HVAC systems required to accommodate the proposed substitution.
i. A list of installations of the proposed substitution indicating application, location, owner and date of first use.

2. Upon receipt of written application for substitution from the Contractor, including the information specified above, the Construction Manager will estimate the cost of evaluating the request and present the estimate to the Contractor. The Contractor is advised that the estimate is based upon the best information available to the Construction Manager at the time; however, the actual cost, based on time and expense, will be documented and applied in the final analysis of the substitution request. If the Contractor wishes to proceed with the request, he shall advise the Construction Manager in writing and submit sufficient additional information as may be requested by the Construction Manager. No evaluation will take place until such time as the Contractor has agreed to the estimate in writing and has authorized the Construction Manager to deduct the cost of the evaluation from monthly progress payments due the Contractor.

1.03 CATEGORIES OF SUBMITTALS

A. General:
a. Submittals fall into three general categories; Action Submittals - Action Submittals require review and response by the Engineer before the Contractor proceeds with incorporating the equipment, materials, or procedure addressed in a submittal into the work. Review comments for Action Submittals, and the subsequent actions of the Contractor based on the review comments, shall conform to REVIEW ACTION requirements specified in this section.
b. Informational Submittals - Informational Submittals are examined to verify that the information has been furnished as specified. If the information has not been furnished as specified the submittal will be returned marked “MAKE CORRECTIONS NOTED” and any deficiencies will be noted. If the information has

been furnished as specified the submittal will be returned marked “RECEIPT ACKNOWLEDGED”.

c. Closeout Submittals – Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following supply of the equipment. Closeout submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the primary equipment. Closeout Submittals require review and response by the Engineer. Closeout Submittal requirements are not satisfied until they have been reviewed and returned marked “NO EXCEPTIONS TAKEN” or “MAKE CORRECTIONS NOTED”.

B. Submittals for review and comment:

1. All submittals except where specified to be submitted as product data for information only shall be submitted by the Contractor to the Construction Manager for review and comment.

C. Submittals (product data) for information only:

1. Where specified, the Contractor shall furnish submittals (product data) to the Construction Manager for Information only. Submittal requirements for operation and maintenance manuals, which are included in this category, are specified in Section 01 78 23.

1.04 TRANSMITTAL PROCEDURE

A. General:

1. All submittals shall be prepared and submitted in electronic format (pdf) complete with cover sheet, index, and bookmarks. Owner may choose to use a Web Based Construction Document Management software; if Owner chooses to use such software, Contractor shall submit all submittals through said software.
2. Unless otherwise specified, submittals regarding material and equipment shall be accompanied by Transmittal Form 01 33 00-A. Submittals for operation and maintenance manuals, information and data shall be accompanied by Transmittal Form 01 78 23-A. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment shall be identified with all the appropriate equipment numbers. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.
3. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Resubmittals shall have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for resubmittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of submittal 25.

a. Prepare resubmittal, if applicable. Clearly identify each correction or change made. Include a response in writing to each of the Engineer’s comments or questions for submittal packages that are resubmitted in the order that the

comments or questions were presented throughout the submittal. Acceptable responses to Engineer's comments are listed below:

1) "Incorporated" Engineer's comment or change is accepted and appropriate changes are made.
2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.

b. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

c. Review costs:

1) Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
2) Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

B. Deviation from contract:

1. If the Contractor proposes to provide material, equipment, or method of work which deviates from the project manual, he shall indicate so under "deviations" on the transmittal form accompanying the submittal copies.

C. Submittal completeness:

1. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

1.05 REVIEW PROCEDURE

A. General:

1. Submittals are specified for those features and characteristics of materials, equipment, and methods of operation which can be selected based on the Contractor's judgment of their conformance to the specified requirements. Other features and characteristics are specified in a manner which enables the Contractor to determine acceptable options without submittals. The review procedure is based on the Contractor's guarantee that all features and characteristics not requiring submittals conform as specified. Review shall not extend to means, methods, techniques, sequences or procedures of manufacture, or to verifying quantities, dimensions, weights or gages, or fabrication processes (except where specifically indicated or required by the project manual) or to safety precautions or programs incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.
2. When the contract documents require a submittal, the Contractor shall submit the specified information as follows:

a. Electronic copies (pdfs) of all submitted information shall be transmitted with submittal cover sheet for review and comment.

B. Submittals for review and comment:

1. Unless otherwise specified, within 7 calendar days after receipt of a submittal for review and comment, the Construction Manager shall review the submittal and return one copy of the marked-up reproducible original noted in 1 above to the Owner. The reproducible original will be retained by the Construction Manager. The returned submittal shall indicate one of the following actions:
    a. If the review indicates that the material, equipment or work method complies with the project manual, submittal copies will be marked "NO EXCEPTIONS TAKEN." In this event, the Contractor may begin to implement the work method or incorporate the material or equipment covered by the submittal.
    b. If the review indicates limited corrections are required, copies will be marked "MAKE CORRECTIONS NOTED." The Contractor may begin implementing the work method or incorporating the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, a corrected copy shall be provided.
    c. If the review reveals that the submittal is insufficient or contains incorrect data, copies will be marked "AMEND AND RESUBMIT." Except at his own risk, the Contractor shall not undertake work covered by this submittal until it has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."
    d. If the review indicates the material, equipment, or work method does not comply with the project manual, copies of the submittal will be marked "REJECTED - SEE REMARKS." Submittals with deviations which have not been identified clearly may be rejected. Except at his own risk, the Contractor shall not undertake work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

C. Submittals (product data) for information only:
    1. Such information is not subject to submittal review procedures and shall be provided as part of the work under this contract and its acceptability determined under normal inspection procedures.

1.06 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS:

A. General:
    1. Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the Construction Manager or the Owner, or by any officer or employee thereof, and the Contractor shall have no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment so reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" shall mean that the Owner has no objection to the Contractor, upon his own responsibility, providing the materials or equipment proposed.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 SITE MAINTENANCE

A. The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

1.02 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site by the Contractor as soon as they are no longer necessary.

1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

1.04 NOISE CONTROL

A. Between 7:30 p.m. and 7:00 a.m., noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at a distance of 50 feet from the noise source.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 ABBREVIATOINS

A. Wherever used in the project manual, the following abbreviations will have the meanings listed:

Abbreviation	Meaning
AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

Abbreviation	Meaning
AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 "L" Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017

Abbreviation	Meaning
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428
AWPA	American Wood-Preservers' Association 9549 Old Fredrick Road Ellicott City, MD 21042
	or P.O. Box 286 Woodstock, MD 21163-0286
AWS	American Welding Society 550 NW LeJeune Road P.O. Box 351040 Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BOCA	Building Officials and Code Administrators, International, Inc. 4051 West Flossmoor Road Country Club Hills, IL 60478
CALTEST	Materials Manual, State of California, Business and Transportation Agency Department of Public Works State of California, Department of Transportation 6002 Folsom Boulevard Sacramento, CA 95819
CALTRANS	Standard Specifications, State of California, Department of Transportation State of California, Business and Transportation Agency P.O. Box 1499 Sacramento, CA 95807
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Red Oak Boulevard, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 N Plum Grove Road Schaumburg, IL 60173
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145

Abbreviation	Meaning
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021
DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
EEI	Edison Electric Institute 90 Park Avenue New York, NY 10016
EIA	Electronic Industries Association Order from: Global Engineering Documents 18201 McDurmott West Irvine, CA 92714
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
ESO	Electrical Safety Orders California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS (see FEDSPECS)	Federal Standards
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062
HEI	Heat Exchange Institute 1300 Sumner Avenue Cleveland, OH 44115
HI	Hydraulic Institute 9 Sylvan Way, Suite 180 Parsippany, NJ 07054
HPVA	Hardwood Plywood & Veneer Association 1825 Michael Faraday Drive P.O. Box 2789 Reston, VA 22090-2789

Abbreviation	Meaning
IAPMO	International Association of Plumbing and Mechanical Officials 20001 Walnut Drive S Walnut, CA 91789
ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA

Abbreviation	Meaning
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NELMA	Northeastern Lumber Manufacturers Association, Inc. P.O. Box 87A Cumberland Center, ME 04021
NEMA	National Electrical Manufacturer's Association 2101 L Street, NW, Suite 300 Washington, DC 20037
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NFOR	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1111 19 Street NW, Suite 700 Washington, DC 20036
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NHLA	National Hardwood Lumber Association 6830 Raleigh LaGrange P.O. Box 34518 Memphis, TN 38184-0518
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PCI	Precast/Prestressed Concrete Institute 175 West Jackson Blvd., Suite 1859 Chicago, IL 60604
PPIC	The Plumbing & Piping Industry Council, Inc. 510 Shatto Place, Suite 402 Los Angeles, CA 90020

Abbreviation	Meaning
RIS	Redwood Inspection Service California Redwood Association 405 Enfrente Dr., Suite 200 Novato, CA 94949
RMA	Rubber Manufacturers Association 1400 K Street NW, Suite 900 Washington, DC 20005
SAE	Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719

Abbreviation	Meaning
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO
UPC	Uniform Plumbing Code Published by IAPMO
USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns St. P.O. Box 23145 Portland, OR 97223
WWPA	Western Wood Products Association (Formerly called: West Coast Lumbermen's Association (WCLA)) Yeon Building 522 SW 5th Avenue Portland, OR 97204

END OF SECTION

SECTION 01 45 00

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for quality control services, field inspections and field testing of civil and structural constructs required for this project.

B. The Contractor is responsible for the quality assurance and quality control of their respective work for the construction of this project in accordance with the Contract Documents.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.

1. Section 01 45 23 Testing and Inspection Services

1.03 DEFINITIONS

A. Quality Control System (QCS): The quality control, assurance, and inspection system established and carried out to ensure compliance with the Plans and specifications.

B. QCS Supervisor: That person in responsible charge of the work occurring, as designated by the Contractor in the QCS Plan.

C. QCS Inspector: Responsible, certified personnel inspecting the various constructs at specified milestones and during the project overall and designated by the Construction Manager.

D. Factory Test: Tests made on various materials, products and component parts prior to shipment to the job site.

E. Field Tests: Tests and analyses made at or in the vicinity of the job site in connection with the actual construction.

F. Certified Inspection Report: Reports signed by approved inspectors attesting that the items inspected meet the specification requirements other than any exceptions included in the report.

G. Certificate of Compliance: Certificate from the manufacturer of the material or equipment identifying said manufacturer, product and stating that the mateiral or equipment meet specified standards, and shall be signed by a designated officer of the manufacturer.

H. Standard Compliance: Condition whereby specified materials or equipment must conform to the standards of organizations such as the American National Standard

Institute (ANSI), American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL) or similar organization.

I. Quality Assurance: The day-to-day, in-process supervisory observations of work and materials conducted by the Contractor to assure that the proper methods and materials are being used and installed by tradesmen.

J. Source Quality Control: The in-process testing and inspections conducted by the QCS Inspector(s) to verify that the materials, equipment; workmanship and shop manufactured constructs are in compliance with the Contract Documents, applicable Codes and standards.

K. Field Quality Control: The testing and inspections conducted by the QCS Inspector(s) in the field during and at the completion of each construct to verify that the in-process and completed construction is in compliance with the Contract Documents, applicable Codes and standards.

L. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the local governing authorities having jurisdiction (AHJ) as having the competency necessary to inspect a particular type of construction requiring special inspection.

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A celectronic copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Written description of Contractor's proposed QCS plan in sufficient detail to illustrate adequate measures for verification and conformance to defined requirements. The QCS plan and submittal shall include a log showing anticipated inspections, QCS Inspectors, Special Inspections, and source and field Quality Assurance procedures. Submittal of the QCS plan shall be made prior to commencing field work.
   5. Contractor's proposed QCS Supervisor and QCS Inspectors (other than the Special Inspectors provided by Owner), including qualifications, responsibilities, and if requested, references.
   6. Complete structural system information describing Contractor designed structural systems, including sealed calculations, shop and erection drawings, product literature for the various components, International Code Council (ICC) Evaluation Reports for structural components, and a discussion of risk issues associated with the proposed system which could adversely impact overall project completion.

7. If requested by the Construction Manager during the work, manufacturer's field services and reports.

A. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' field services and reports unless requested by Construction Manager to be submitted for review.
   3. Special Inspection reports, unless otherwise directed in each technical specification Section.

1.05 REGULATORY REQUIREMENTS

A. GENERAL: Comply with all Federal, State, and local Codes as referenced herein. Such regulations apply to activities including, but not limited to, site work and zoning, building practices and quality, on and offsite disposal, safety, sanitation, nuisance, and environmental quality.

B. SPECIAL INSPECTION: Special Inspection shall be performed by the Special Inspector under contract with the Owner or registered design professional in responsible charge acting as the Owner's agent in conformance with the IBC. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

C. STRUCTURAL OBSERVATION: Registered Design Professional shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system in accordance with IBC 1704.6 Structural Observations requirements.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Monitor quality assurance over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Coordinate with, schedule specified inspections by, and provide normal and customary assistance to the QCS Inspectors and Owner provided Special Inspectors.

C. Coordinate with, schedule specified structural observations by Engineer, and provide normal and customary assistance to Engineer performing structural observations.

D. Comply fully with manufacturers' instructions, including each step in sequence.

E. Should manufacturers' instructions conflict with Contract Documents, request clarification before proceeding from Construction Manager.

F. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

G. The Contractor shall retain the services of a licensed land surveyor, registered in the State of Utah to perform survey work including but not limited to establishing line and grade, in advance of the construction; and to perform other surveying services for the work included under the Contract. The surveyor to be retained by the Contractor shall not be the same surveyor engaged for the Engineer's use. The surveyor shall be subject to the approval of the Engineer. Survey drawings shall be submitted to the Engineer for approval.

H. The Contractor shall take all necessary measurements in the field to verify pertinent data and dimensions shown on the Drawings or to determine the exact dimensions of the Work.

1.07 FIELD SAMPLE PROCEDURES

A. When field samples are specified in a unit of work, construct each field sample to include work of all trades required to complete the field sample prior to starting related field work. Field samples may be incorporated into the project after acceptance by Construction Manager. Remove unacceptable field samples when directed by Construction Manager. Acceptable samples represent a quality level for the work.

1.08 CONTRACTOR DESIGNED STRUCTURAL SYSTEMS

A. DESIGN ENGINEERING: Contractor shall employ and pay for engineering services from a Professional Engineer registered in the State of Utah for structural design of Contractor designed structural systems including but not limited to temporary shoring and bracing, formwork support, interior wall and ceiling systems, and support systems for fire sprinkler, plumbing, mechanical, and electrical systems and equipment.

B. TESTS AND INSPECTIONS OF CONTRACTOR DESIGNED STRUCTURAL SYSTEMS: Contractor shall pay for preliminary testing of concrete, grout, and mortar mix designs where required by Code or these specifications prior to start of work. Contractor shall pay for required shop and site inspection of Contractor designed structural systems where required by Code or these specifications.

1.09 JOB SITE CONDITIONS

A. Schedule to ensure all preparatory work has been accomplished prior to proceeding with current work. Proceeding with the work constitutes acceptance of conditions. Allow adequate time for materials susceptible to temperature and humidity to “stabilize” prior to installation. Establish and maintain environmental conditions (i.e., temperature, humidity, lighting) as recommended by the various material manufacturers for the duration of the work.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. CONTRACTOR RESPONSIBILITIES: Provide source quality control according to the reviewed and accepted QCS plan and paragraph 1.06 herein. Coordinate with Construction Manager to facilitate the work of the Testing Laboratory specified in Section 01 45 23 and Special Inspector. Provide ready access to sampling and inspection

locations and incidental labor customary in such sampling and inspections. Timely prepare and submit submittals, and revise as indicated by review comments. Comply with technical requirements in each specification Section that applies to the work.

B. CONSTRUCTION MANAGER RESPONSIBILITIES: Review Contractor's tracking of QCS activities at monthly meetings. Facilitate completion of submittal review per Section 01 33 00. Assist Contractor to ensure that Special Inspection occurs where and when specified.

C. ACCEPTANCE CRITERIA: Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Field quality control responsibilities of the Contractor and Construction Manager are substantially the same as described in paragraph 2.01, with the exception that this work occurs primarily on the jobsite as the work progresses, and Special Inspection will occur more often than at the source.

B. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

3.02 REGULATORY COMPLIANCE – SPECIAL INSPECTIONS

A. The types of work requiring Special Inspection are specified in the Construction Documents and required to obtain regulatory approval by State or required by local governing authorities having jurisdiction over the building permit of the project.

B. Section 01 45 23 describes Testing Laboratory sampling, testing and reporting.

C. Contractor designed structural systems are subject to the same Special Inspection requirements as all other work.

3.03 CORRECTION OF DEFECTIVE WORK

A. Any defective or imperfect Work, equipment, or materials furnished by the Contractor which is discovered before the Final Acceptance of the Work, or during a warranty period, shall be removed immediately even though it may have been overlooked by the Engineer and approved for payment. The Contractor shall repair such defect, without compensation, in a manner satisfactory to the Engineer.

B. Unsuitable materials and equipment may be rejected, notwithstanding that such defective Work, materials and equipment may have been previously overlooked by the Engineer and accepted or approved for payment.

C. If any workmanship, materials or equipment shall be rejected by the Engineer as unsuitable or not in conformity with the Specifications or Drawings, the Contractor shall promptly replace such materials and equipment with acceptable materials and

equipment at no additional cost to Owner. Equipment or materials rejected by the Engineer shall be tagged as such and shall be immediately removed from the site.

D. The Engineer may order tests of imperfect or damaged Work equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor, and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the Work, equipment, or material was not impaired, the Work, equipment or materials may be deemed acceptable, in the discretion of the Engineer. If the results of such tests reveal that the required functional capability of the questionable Work, equipment or materials has been impaired, then such Work, equipment or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect Work, equipment or material in lieu of performing the tests.

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTION SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. GENERAL REQUIREMENTS: Comply with the testing and inspection specified in this Section and elsewhere in the Construction Documents. For the purpose of this Section, all references made herein to Testing Agency or Special Inspector or Geotechnical Consulting Firm shall be referred to as those tests or inspections which will be conducted by an inspector provided by the Owner.

1. The Owner or registered design professional in responsible charge acting as the Owner's agent will select and employ an independent Testing Agency to conduct the tests and inspections in accordance with applicable standard methods of American Society for Testing and Materials (ASTM) or other standards specified by the local governing Authorities Having Jurisdiction (AHJ) as a requirement of the building permit. The Owner may require other special inspection services to inspect and verify the Work installed is in accordance with the Construction Documents and construction industry standards.
2. The Contractor shall provide and pay for other inspection and testing services where specified in the Construction Documents or required to obtain regulatory approval by State or AHJ.

1.02 DEFINITIONS

A. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the AHJ as having the competency necessary to inspect a particular type of construction requiring special inspection.

B. Testing Agency - firm responsible for performing specific inspections and/or tests as part of the Special Inspection program.

1.03 QUALITY ASSURANCE

A. QUALIFICATIONS: The inspector for all Work as hereinafter specified, except for geotechnical inspections, waterproofing and roofing, shall be a registered Special Inspector employed by an approved inspection and/or Testing Agency All inspection personnel used on this Project are subject to being disapproved from the Project at the discretion of the Owner.

1. The Special Inspector shall have the required technical knowledge and experience for the product or construction element being installed.
2. Geotechnical Inspection will be performed by a licensed Geotechnical Consulting Firm.

1.04 DUTIES OF OWNER'S TESTING AGENCY

A. GENERAL: The Owner's Testing Agency will conduct testing and inspection services, interpret them, and evaluate the results for compliance with the building permit, the site development permit, and the Construction Documents; agency will report findings to the Owner, Contractor, and AHJ. Testing and inspection services shall be in accordance with applicable standard methods of ASTM or other standards specified by AHJ, the Construction Documents, and construction industry standards. The Testing Agency will reasonably support overtime, second shift, and out-of-area activity if requested by the Contractor and approved at the Owner's sole discretion.

B. TESTING AND INSPECTION: Materials to be tested are specified by the building permit and as required by the Construction Documents, as directed by Owner, or required by AHJ. Quantities and extent of tests and inspections shall be as specified and/or required by the Owner's Inspector or AHJ.

C. NON-CONFORMING WORK: The Owner's Inspector shall document and immediately notify the Contractor and Owner of any Work found defective or not in accordance with the requirements of the Construction Documents. Non-conforming Work shall be corrected.

D. The Owner's inspectors are not authorized to do the following:
   1. Release, revoke, alter or enlarge on requirements of Construction Documents.
   2. Approve or accept any portion of the Work, except as allowed by the special inspection duties delegated by governing AHJ for building permit inspections and testing.
   3. Perform any duties of the Contractor.
   4. Stop Work.

1.05 COSTS

A. The Owner's Testing Agency and Special Inspector costs for initial testing and inspection as specified in the Construction Documents will be paid for by the Owner or registered design professional in responsible charge acting as the Owner's agent . Initial tests and inspections are defined as those required to complete the first tests and inspections specified. Costs for subsequent re-testing and re-inspection of items found not to be in compliance with Construction Documents shall be borne by the Contractor.

B. Additional tests and inspections not herein specified, but requested by the Owner, shall be paid for by the Owner. However, if the results of such tests or inspections are found to be not in compliance with Construction Documents, the Contractor will be back charged for all costs for initial testing as well as re-testing, re-inspection and Owner's Consultants services.

C. Costs for additional tests or inspections required because of Contractor changes to reviewed and accepted products or materials provided, or source, or supply shall be borne by the Contractor.

D. Costs for any Work which is required to correct any deficiencies shall be borne by the Contractor.

E. Costs of any testing which is required solely for the convenience of Contractor in its scheduling and performance of the Work shall be borne by the Contractor.

F. Costs for verification testing of Work done without prior notice, with improper supervision, or contrary to construction practice shall be borne by the Contractor.

G. Costs for testing of materials for which fabrication and mill reports are required but not furnished shall be borne by the Contractor.

H. The cost, if any, of providing access for inspections and tests shall be considered part of the normal expense of conducting business and therefore non-reimbursable.

I. In those instances where inspector(s) arrive at the agreed-upon location, at the agreed upon date and time, and find articles to be inspected are not ready for inspection, the inspector(s) shall return to their home office and all expenses incurred shall be borne by the Contractor.

1.06 TESTS AND INSPECTION REPORTS

A. Copies of Owner and Contractor test and inspection reports shall be distributed at weekly intervals. All reports will be signed by a certified Special Inspector or Professional Engineer registered in the State of Utah as appropriate. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory; a final report should be submitted documenting corrective work done on of any unsatisfactory material and or work identified in the testing or inspection reports. Samples taken, but not tested, shall also be reported. Records of special sampling operations that are required shall also be reported. Test and inspection reports shall be distributed as follows:
   1. Owner
   2. Owner's Testing Agency
   3. Contractor
   4. Authority Having Jurisdiction

B. A report shall be prepared for each inspection and test and shall include:
   1. Date issued
   2. Project title and number
   3. Name and signature of inspector
   4. Date of inspection or sampling and test
   5. Record of temperature and weather
   6. Identification of product and Specification Section
   7. Location in Project
   8. Type of inspection or test
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards

1.07 CONTRACTOR'S RESPONSIBILITIES

A. COORDINATION: It is the Contractor's responsibility to initiate, coordinate, and conform to the required tests and inspections of governing State and AHJ. Inspection of the Work by the Owner's Special Inspectors and/or Testing Agency shall not relieve the Contractor from responsibility for compliance with the Construction Documents requirements. Owner's Special Inspectors and/or Testing Agency and Owner shall have authority to reject Work whenever the provisions of the Construction Documents are not being complied with, and the Contractor shall instruct his employees accordingly.

B. ACCESS FOR THE PURPOSE OF INSPECTION: Ensure the Owner's Special Inspectors and/or Testing Agency have free access to all parts of the Work and to the shops where the Work is in preparation; are provided proper facilities and safe access for such inspection; and are reasonably furnished access, equipment, tools, samples, certifications, test reports, design mixes, storage, and assistance as requested by the Owner's Inspector.

C. STORAGE FACILITIES: Furnish adequate storage facilities as approved by the Owner for the sole use of the Owner's Testing Agency for safe storage and curing of such specimens which must remain on the site prior to transport to the laboratory.

D. DATA: Furnish records, Contract Drawings and shop drawings, certificates, approved Change Orders, and similar data as required by Owner's Inspectors to perform their work to assure compliance with the Construction Documents.

E. NOTICE: Furnish notice to Owner and coordinate with Owner's Inspectors a minimum of five (5) working days in advance of all required tests and a minimum of forty-eight (48) hours in advance of all required inspections, unless otherwise specified.

F. NON-CONFORMING WORK: Remove and replace Non-conforming Work at no additional cost to the Owner prior to Final Completion. Where Non-conforming Work requires design modifications, such re-design shall be performed by the Engineer of Record and costs shall be borne by the Contractor.

G. CANCELLATIONS: Contractor shall give sufficient advance notice to Owner and Inspectors to allow rescheduling of their work load in the event of cancellation or time extension of any scheduled test or inspection

1.08 TEST FAILURES

A. GENERAL: The Owner may require re-test of a sampled material when a sample or procedure has failed to pass the required tests. In the event any test or inspection indicates failure of a material or procedure to meet requirements of Construction Documents, all costs for re-testing or re-inspection shall be borne by the Contractor. The Contractor may opt to replace the imperfect Work, equipment or material in lieu of performing the tests.

1.09 REPORT TEST FAILURES

A. GENERAL: Immediately upon determination of a test failure, the Owner's Inspector shall notify the Owner and Contractor. By the end of the following day the Owner's Inspector shall send written test results to those named on the distribution list.

B. Contractor shall similarly report test failures to Owner resulting from work of testing agencies provided by the Contractor.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 51 00

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 OFFICE

A. The Contractor shall maintain a suitable office at the site of the work.

1.02 POWER

A. The Contractor shall provide power for construction at the plant site. He shall make arrangements with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising therefrom. The Contractor shall provide the special connections required for his work.

1.03 SANITARY FACILITIES

A. The Contractor shall provide toilet and washup facilities for his work force at the site of work. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

1.04 POTABLE WATER

A. Owner will provide potable water upon contractor request. Contractor will be required to have a back flow prevention device for all water tie-ins.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 GENERAL

1.01 DAMAGE

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Construction Manager.

1.02 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 2 EQUIPMENT

2.01 PACKAGE AND MARKING:

A. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

B. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

2.02 IDENTIFICATION:

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

2.03 SHIPPING:

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

2.04 FACTORY APPLIED COATINGS [NOT USED]:

2.05 STORAGE:

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

C. JTWTP tent on the east end of Basins 1 and 2 shall be made available for use by the Contractor. Contractor is responsible for any damages caused by them or their subcontractors, suppliers, and deliverers.

2.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION:

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed, and accepted and the ventilation systems installed.

END OF SECTION

SECTION 01 73 24

DESIGN REQUIREMENTS FOR
NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/HVAC/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in ASCE 7.

D. Design and conform to criteria and design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the Drawings or where the size of attachments, anchorage, or bracing is defined in specific technical specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.
   1. Components in Seismic Design Category A.
   2. Furniture (except permanent floor supported storage cabinets over 6 ft tall).
   3. Temporary or movable equipment.
   4. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, I_p, is equal to 1.0.
   5. Mechanical and electrical components in Seismic Design Category B.
   6. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.
   7. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
      a. The component importance factor, I_p, is equal to 1.0;
      b. The component is positively attached to the structure;
      c. Flexible connections are provided between the component and associated ductwork, piping, and conduit;
      d. And either:
         1) the component weighs 400 lb or less and has a center of mass located 4 ft or less above the adjacent floor level; or
         2) the component weighs 20 lb or less, or in the case of a distributed systems, 5 lb/ft or less.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.
   1. Section 46 43 11: Chain and Flight Equipment

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AAMA	American Architectural Manufacturer's Association
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASTM C635	Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code with local amendments
NFPA-13	Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems
UOSH	Utah Occupational Safety and Health Act

1.04 DEFINITIONS

A. Structure: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

B. Non-structural Components: Non-structural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist effects of wind, snow, impact, temperature and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: Self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Bidder with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide Drawings and design calculations stamped by a Utah licensed professional engineer qualified to perform structural engineering.
   5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
   6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
   7. Shop drawings showing plans, elevations, sections and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
   8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Bidder shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
   9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in design calculations.

1.06 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory

shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

2.02 DESIGN CRITERIA

A. Design Codes

Design	Code
Buildings/Structures:	International Building Code (IBC) 2018 and ASCE 7-16
Reinforced concrete:	ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, ACI 318-14 for all other reinforced concrete
Structural steel:	AISC 360-16 and AISC 341-16
Aluminum:	Aluminum Design Manual, Latest Edition
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	OSHA and DOSH

Note: When conflicting requirements occur, the most stringent requirements will govern the design.

B. Design Loads
   1. Design non-structural components and non-building structures for the following minimum loads: (Do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
   2. Dead Loads:
      a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
      b. Typical allowance for piping and conduit: 20 psf
   3. Uniform Live Loads:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Exitways, stairs and landings:	100 psf
Equipment platforms, walkways/catwalks (other than exitways):	100 psf
Utility bridges:	75 psf per level

   4. Snow Loads:

Code:	IBC 2018 & ASCE 7
Risk Category:	IV

Drifting:	Per ASCE 7
Ground Snow Load (pg):	37 psf

5. Wind Loads:

Code:	IBC 2018 & ASCE 7-16
Risk Category:	IV
Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above:	113 mph
Exposure:	C
Topographic Factor (K_{zt})	1.0

Note:

1. *Design exterior non-structural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.*

6. Seismic Loads:

Code:	IBC 2018 & ASCE 7-16
Risk Category:	IV
0.2 Sec. Mapped Spectral Response, S_S:	0.835 g
1.0 Sec. Mapped Spectral Response, S_1:	0.271 g
Site Class:	C
0.2 Sec. Design Spectral Response, S_{DS}:	0.593 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.276 g
Importance Factor (I_e):	1.5
Component Importance Factor (I_p):	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7
Seismic Design Category	D

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*
3. *Consider hydrodynamic forces on submerged equipment per code as applicable*

7. Impact Loads:
   a. Consider impact loads in design of support systems.
   b. Use the following impact load factors unless recommendations of the equipment manufacturer will cause a more severe load case:

Rotating machinery:	20% of moving load
Reciprocating machinery:	50% of moving load

8. Temperature:
   a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations

1. Design non-structural components and non-building structures to withstand load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, ignore the load when evaluating that member.

D. Design Considerations
   1. Design non-structural components and non-building structures for the following conditions:
   2. Climatic Conditions: Reference Section 01 11 80 Environmental Conditions.
   3. Foundations:
      a. Extend foundations supporting non-structural components and non-building structures below the frost line, or support on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	30 inches

Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

E. Column Base Fixity
   1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
   2. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection
   1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
   2. Maximum total load deflection for equipment support: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Bidder.

B. Anchorage of equipment is specified to be made by epoxy anchor bolts in concrete elements unless specifically noted otherwise on the Drawings or other specification sections. The Contractor is responsible for remedial work or strengthening (of concrete elements because of superimposed seismic loading) if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to Owner or Bidder.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. Bidder is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Owner.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 STRUCTURES

A. The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Owner, remove such existing structures, including curbs, gutters, pipelines and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. He shall also repair existing structures which may be damaged as a result of the work under this contract.

1.02 ROADS AND STREETS

A. Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving specifications.

1.03 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

A. Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Construction Manager.

B. Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

1.04 PROTECTION OF EXISTING INSTALLATIONS

A. The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. General:
   1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions:
   1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
      a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
      b. Operator Prestart: Provide requirements to set up and prepare each system for use.
      c. Start-Up, Shutdown, And Postshutdown Procedures: Provide a control sequence for each of these operations.
      d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
      e. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
      f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
      g. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance:
   1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02 Operator Service Requirements.
    1) A table showing recommended lubricants for specific temperature ranges and applications;
    2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
    3) A lubrication schedule showing service interval frequency.
b. Preventive Maintenance Plan And Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. Corrective Maintenance:
1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
    a. Troubleshooting Guides And Diagnostic Techniques: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
    b. Wiring Diagrams And Control Diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
    c. Maintenance And Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
    d. Removal And Replacement Instructions: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.
    e. Spare Parts And Supply Lists: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
    f. Corrective Maintenance Manhours: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices:
1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

a. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

b. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. Testing Equipment And Special Tool Information: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00 accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 99 90. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

B. Two physical copies of the specified O&M information shall be provided along with a digital copy. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT

A. Acceptable O&M information for the project must be delivered to the Construction Manager prior to the project being 65 percent complete. Progress payments for work in excess of 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

1.05 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DRAWINGS

A. Record drawings refer to those documents maintained and annotated by the Contractor during construction and are defined as
   1. a neatly and legibly marked set of contract drawings showing the final location of piping, equipment, electrical conduits, outlet boxes and cables;
   2. additional documents such as schedules, lists, drawings, and electrical and instrumentation diagrams included in the specifications; and
   3. Contractor layout and installation drawings.

B. Unless otherwise specified, record drawings shall be digital full sized documents in pdf format. Record documents shall not be used for construction purposes and shall be available for review by the Construction Manager during normal working hours at the Contractor's field office. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

C. Marking of the drawings shall be kept current and shall be done at the time the material and equipment are installed. Annotations to the record documents shall be made conforming to the following color code:
   1. Additions - Red
   2. Deletions - Green
   3. Comments - Blue
   4. Dimensions - Gray

**Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.*

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 50 percent of the contract amount and not less than 3 weeks prior to the provision of training.
   1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
   2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at the site of the work in Herriman, Utah at the Jordan Valley Water Treatment Plant

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:
   1. Familiarization
      a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
      b. Check out the installation of the specific equipment items.
      c. Demonstrate the unit and indicate how all parts of the specifications are met.
      d. Answer questions.
   2. Safety
      a. Using material previously provided, review safety references.
      b. Discuss proper precautions around equipment.
   3. Operation
      a. Using material previously provided, review reference literature.
      b. Explain all modes of operation (including emergency).
      c. Check out Owner's personnel on proper use of the equipment.
   4. Preventive Maintenance
      a. Using material previously provided, review preventive maintenance (PM) lists including:
         1) Reference material.
         2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
      b. Show how to perform PM jobs.
      c. Show Owner's personnel what to look for as indicators of equipment problems.
   5. Corrective Maintenance
      a. List possible problems.
      b. Discuss repairs--point out special problems.
      c. Open up equipment and demonstrate procedures, where practical.
   6. Parts
      a. Show how to use previously provided parts list and order parts.
      b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives
    a. Where to order parts: name, address, telephone.
    b. Service problems:
        1) Who to call.
        2) How to get emergency help.
8. Operation and Maintenance Manuals
    a. Review any other material submitted.
    b. Update material, as required.

2.05 VIDEO RECORDING:

A. The Owner will digitally record each training session. After recording, the material may be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be recorded and shall make available to the Owner such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 EXECUTION

3.01 SUMMARY

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.
    1. As a minimum classroom equipment training for operations personnel will include:
        a. Using PowerPoint slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
        b. Purpose and plant function of the equipment.
        c. A working knowledge of the operating theory of the equipment.
        d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
        e. Identify and discuss safety items and procedures.
        f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
        g. Operator detection, without test instruments, of specific equipment trouble symptoms.
        h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and round checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform start-up and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Start-up and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long-term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as lubrication; normal maintenance such as bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform start-up and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

PART 1 FORMS

1.01 DESCRIPTION

A. The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01 33 00-A	Submittal Transmittal Form
01 78 23-A	Operation and Maintenance Transmittal Form
01 78 23-B	Equipment Record Form
01 78 23-C	Equipment Record Form
09 90 00-A	Coating System Inspection Checklist
26 05 00-A	Wire and Cable Resistance Test Data Form
26 05 00-B	Installed Motor Test Data Form
26 05 00-C	Dry Transformer Test Data Form
26 05 00-D	Motor Control Center Test Form
26 05 00-E	Medium Voltage Motor Starter Test Form
26 05 00-F	Medium Voltage Switchgear Test Form
26 05 00-G	Protective Relay Test Form
26 05 00-H	Low Voltage Switchgear Test Form
26 05 00-I	Medium Voltage Load Interrupter Switch Test Form
26 05 00-J	Liquid-Filled Transformer Test Form
26 05 00-K	Automatic Transfer Switch Test Form
26 05 00-L	Neutral Grounding Resistor Test
40 61 13-A	Loop Wiring and Insulation Resistance Test Data Form
40 61 13-B	Control Circuit Piping Leak Test Form
40 61 13-C	Controller Calibration Test Data Form
40 61 13-D	Panel Indicator Calibration Test Data Form
40 61 13-E	Recorder Calibration Test Data Form
40 61 13-F	Signal Trip Calibration Test Data Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration Test Data Form
40 61 13-I	Miscellaneous Instrument Calibration Test Data Form
40 61 13-J	Individual Loop Test Data Form
40 61 13-K	Loop Commissioning Test Data Form

01 33 00-A. SUBMITTAL TRANSMITTAL FORM

Submittal Transmittal

Submittal Description:	Submittal No:[1]	Spec Section:

	Routing	Sent	Received
Owner:	Contractor/CM		
Project:	CM/Engineer		
	Engineer/CM		
Contractor:	CM/Contractor		

We are sending you:
☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]*Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected*
Attach additional sheets if necessary.

Contractor

Certify either a or b:

a. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

b. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

Certified by: _____

Contractor's Signature: _____

[1]See *Section 01 33 00-1.04. A, Transmittal Procedure.*

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:[2]
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

Checklist	Contractor		Construction Manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and postshutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks:

Contractor's Signature :

[2] See Section 01 33 00-1.04.A, Transmittal Procedure.

01 78 23-B. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

Lubricants: Recommended:

Alternative:

Misc. Notes:

Recommended Spare Parts					Electrical Nameplate Data			
Part No	Quan	Part Name	Cost		Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	V	Amp	Hz
					Ph	Rpm	Sf	Duty
					Code	Insl. Cl	Des	Type
					Nema Des	C Amb	Temp Rise	Rating
					Misc.			
					Mechanical Nameplate Data			
					Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	Rpm	Cap	Size
					Tdh	Imp Sz	Belt No.	Cfm
					Psi	Assy No.	Case No.	
					Misc			

01 78 23-C. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

						Ambient temp	°F
Resistance:							
Insulation resistance phase-to-ground megohms:							
Phase A		Phase B		Phase C			
Current at Full Load:							
Phase		Current, amps					
Phase		Current, amps					
Phase		Current, amps					
Thermal Overload Device:	Manufacturer/catalog #		Amperes				
Circuit breaker (MCP) setting:							

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating		°C	
Time rating				Design letter**			
	(NEMA 1-10.35)				(NEMA MG-1.16)		
Code letter				Insulation class			

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-C. DRY TRANSFORMER TEST DATA FORM

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: _____ Secondary Voltage: _____ Winding Connection: _____

A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N-G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	A			
	B	B			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed:_____ Date _____

26 05 00-D. MOTOR CONTROL CENTER TEST FORM

Equipment No.: _____ Ambient room temperature: _____

Location: _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD		A-B	
B-GRD		B-C	
C-GRD		C-A	

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-E. MEDIUM VOLTAGE MOTOR STARTER TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.
4. Motor RTDs shall be tested by using a hot oil bath. The temperature at which the sensor trips shall be recorded for each RTD.
5. The Contactor shall be tripped by operation of each protective device.

26 05 00-F. MEDIUM VOLTAGE SWITCHGEAR TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Perform minimum pickup voltage tests on trip and close coils.
4. Verify the instrument transformer ratios. Check the transformer's polarity electrically.
5. The Contactor shall be tripped by operation of each protective device.

26 05 00-G. PROTECTIVE RELAY TEST FORM

Location: _____

Switchgear Breaker No.: _____

Protective Relay Description: _____

The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.
2. Perform the following tests on the specified relay setting:
    a. Pickup parameters on each operating element.
    b Timing test shall be performed at three points on the time dial curve.
    c. Pickup target and seal-in units.

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 26 05 00-1.05 Corrosive Areas.

26 05 00-H. LOW VOLTAGE SWITCHGEAR TEST FORM

Equipment No.: _____

Location: _____

Room Temperature: _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

3. Minimum pickup current shall be determined by primary current injection.
4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.
5. Short time pickup and time delay shall be determined by primary injection of current.
6. Instantaneous pickup current shall be determined by primary injection.
7. Trip unit reset characteristics shall be verified.
8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

26 05 00-I. MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM

Equipment Number: _____

Location: _____

Date: _____

1. Measure switch blade resistance (micro-ohms).

Phase:	A		B		C	

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A		B		C		
Pole to ground							megohms
Across open pole							megohms
Pole to pole	AB		BC		CA		megohms

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 26 05 00-2.06 Product Data.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-J. LIQUID-FILLED TRANSFORMER TEST FORM

Equipment Number: _____

Location: _____

Date/Weather Conditions: _____

A. Perform the "Insulation-Resistance Test" and "Dielectric Absorption Test" using Form 26 05 00-C, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, paragraph 10.5, Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00, Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:

1. Dielectric strength.
2. Acid neutralization.
3. Interfacial tension.
4. Color.
5. Power factor.

D. Perform a turns ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

F. The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 26 05 00-2.06 Product Data. Any readings which are abnormal to ANSI industry standards shall be reported to the Construction Manager.

26 05 00-K. AUTOMATIC TRANSFER SWITCH TEST FORM

Equipment Number: _____

Location: _____

Date: _____

1. Perform an insulation resistance test (1000 volts DC for 1 minute):

Phase	A		B		C		
Pole to ground							megohms
Pole to pole	AB		BC		CA		megohms

2. Perform the following operations and initial:

   a. Manual transfer _____

   b. Loss of normal power; __sec delay

   c. Return to normal power; _____sec delay

The results shall be recorded and signed. A copy shall be given to the Construction Manager in accordance with paragraph 26 05 00-2.06 Product Data.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-L. NEUTRAL GROUNDING RESISTOR TEST

Equipment No.: _____

Location: _____

The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 26 05 74.

1. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.
2. The protective relay pickup current shall be determined by injecting test current into the current sensor. The pickup current should be within 10 percent of the dial setting. Record the dial setting and actual pickup tie.
3. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer's published time-current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.
4. The circuit interrupting device shall be operated by operating the relay.

The results shall be recorded and signed by the Contractor and Construction Manager. A copy shall be given to the Construction Manager in accordance with paragraph 26 05 00-2.06 Product Data.

40 61 13-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

Wire No.	Panel Tie	Field TB	Continuity Resistance[a]		Insulation Resistance[b]			
			Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-B. CONTROL CIRCUIT PIPING LEAK TEST FORM

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 1/4-Inch Copper[a]	Test Period (seconds)	Permitted Pressure Drop (psi)[b]	Measured Pressure Drop (psi)
A				
B				
C				
D				
etc.				

NOTES:

a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-C. CONTROLLER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev.	OUTPUT	OUTPUT	% Dev.
(0%)								
(50%)								
(100%)								
% Deviation Allowed:			% Deviation Allowed:			% Deviation Allowed:		

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-D. PANEL INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.:_____ Serial No.:_____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-E. RECORDER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Chart: _____

Scale: _____ Range: _____

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-F. SIGNAL TRIP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:

(Attach test form 40 61 13-A)

b. Instrumentation tubing/piping tested:

(Attach test form 40 61 13-B)

c. Instruments calibrated:

(Attach test forms 40 61 13-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 01 00

CONCRETE REPAIR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes concrete rehabilitation of existing basin no. 3 through 6.
   1. Inspection by Engineer and Contractor to identify areas in need of repair and extent of repair expected.
   2. Repair by Contractor, as coordinated with product manufacturers for final product selections, in accordance with this specification and drawings, including preparation, repair, and protective coating.
   3. Materials for reinforcement steel modifications below and for cast-in-place concrete construction for new walls shall comply with specification section 03 20 00 Concrete Reinforcing.

1.02 UNIT PRICE

A. Work includes cost of preparing existing construction to receive Work indicated, installation of repair products, curing, and costs of field quality control.

1.03 RELATED SECTIONS

A. Section 01 12 16 – Work Sequence

B. Section 03 20 00 – Concrete Reinforcing

C. Section 03 30 00 – Cast-In-Place Concrete

1.04 REFERENCE

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between requirements of this section and those of listed documents, requirements of this section prevail.

B. References listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version referenced by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids, Invitation to Bid, or the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. For questions, refer to Engineer.

C. ACI–562 – Assessment, Repair and Rehabilitation of Existing Concrete Structures and Commentary.

1.05 PRECONSTRUCTION MEETING

A. Contractor to organize and conduct a preconstruction meeting, at Project site prior to start of work related to this Section. Include representatives from Contractor, Subcontractor, repair product representatives, Coating manufacturer's representative, Engineer, and Owner.

B. Review methods and procedures related to concrete repairs and protective coating including, but not limited to, the following:
   1. Verify Contractor's personnel, equipment, and facilities needed to perform Work and avoid delays.
   2. Materials, surface preparation, material application, environmental conditions, curing, sequencing, tolerances, and required clearances.
   3. Coordination of Work, including schedule to include provisions for mockup of surface preparation, repair mortar, finish coatings, and testing.
   4. Quality-Control program, including required notifications and scheduling of inspections by Contractor, product manufacturers, Engineer, and Owner's testing agency.

1.06 ACTION SUBMITTALS

A. Concrete Repair Schedule.
   1. Include proposed dates for bypass pumping, draining of structures, cleaning, inspection, and completion of Work.

B. Concrete Repair Plan
   1. Include quantities for each type of repair material based on field inspection.

C. Product Data:
   1. Include product data for each product to be used, based on recommendations of product manufacturers.
   2. Include construction details, material data sheets, chemical composition, physical properties, test data, and mixing information.
   3. Include custom, project specific selections defined in the with preparation and application instructions for repair materials per manufacturer's recommendations.
   4. Coordinate repair materials with protective coating submittals per contract drawings and provide written confirmation from coating manufacturer regarding compatibility of coating with selected repair products.
   5. Standard submittal documents are required, marked up to indicate selected products and applicable information. Indicate locations of Contractor requested substitutions. Do not submit full catalogs. Do not submit MSD sheets.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Specialty concrete repair Contractor and manufacturers, plus Specialty coating Contractor and manufacturer, based on Quality Assurance requirements below.

B. Product Test Reports: For each manufacturer and each product, including: bonding agent, cementitious patching mortar, joint-filler, crack-injection adhesive, and structural reinforcement; for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Quality-Control Program: Submit before work begins; to include product manufacturer approval of installation personnel.

D. Field quality-control tests and observation reports provided by Contractor and product manufacturer representatives. Include pH testing, maximum and minimum surface temperature records, daily maximum and minimum ambient air temperature and humidity readings, and wind speeds prior to and for 48 hours after product installation.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: Each product manufacturer shall employ factory-authorized service representatives who are available for consultation and Project-site inspection and assistance.
   1. Coordinate services of the repair/coating product manufacturer's representative(s) to: attend the preconstruction meeting, provide additional field training, be on-site to monitor mockup, examine surfaces after preparation, mixing of products and application; and be available as-needed thereafter during repair/coating production, provide follow-up observation of curing and finished repair/coating, provide on-site trouble shooting and corrective procedures.
   2. A single source Manufacturer shall provide all products used in the "system" for restoration of concrete surface including protective coatings per contract drawings. Where more than one manufacturer's products are used in the "system", each manufacturer shall provide a complete list of all products in the "system", including the selected products from other manufacturer's and provide a statement regarding acceptance of compatibility.

B. Specialty Concrete Repair Contractor Qualifications: Engage an experienced specialty concrete-repair firm that employs installers and supervisors who are trained and approved by the manufacturer to perform Work of this Section. The firm shall have completed Work similar in material, design, and extent to that indicated for this Project and shall demonstrate a record of successful in-service performance.
   1. Concrete repair Contractor shall have at least 5-years' experience using product(s) being installed (or similar) and demonstrate a history with projects of similar size and complexity as the Work intended for this Project.
      a. Provide evidence (certificates or letter) of Contractor training by manufacture.
   2. Field Supervision: Concrete repair firm shall maintain experienced full-time supervisors on Project site during times that concrete-repair Work is in progress.

C. Quality Control Program: Prepare a written plan for concrete repair to systematically demonstrate the ability of selected personnel to properly perform the Work. Include each

phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail, using outline format: materials, methods, equipment to be used; how environmental conditions will be monitored; testing, and sequence of operations to be used for each phase of Work.

D. Provide pH testing (including written documentation) of prepared concrete surface to determine required depth of removal to obtain a pH neutral surface prior to application of repair materials. Reference ASTM D4262.

E. A third-party testing agency hired by Contractor shall spot check the pH of prepped surfaces and perform the following test in the mock-up area prior to application of protective coatings.
   1. Direct-tension bond testing of prepared surface.
   2. Direct-tension bond testing of completed repair.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions, including minimum and maximum temperature requirements and other requirements.

B. Store materials off ground, under cover, and in a dry location.

1.10 FIELD CONDITIONS

A. General: Install products according to manufacturer's instructions. Consult product manufacturer for environmental limitations. Plan Work and install products only during permissible temperature range specified by manufacturer's instructions.

B. Cold-Weather Requirements: Do not apply unless concrete-surface and air temperatures are above 40 deg F and will remain so for at least 48 hours after completion of Work or as directed by manufacturer.
   1. If mean daily air temperature falls below 40 deg F, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 40 deg F within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade, wet cure methods, wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F and above.

PART 2 PRODUCTS

2.01 GENERAL

A. Source Limitations: For repair products, where practical, obtain each grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

B. All materials shall be free of chlorides and other chemicals causing corrosion.

2.02 REINFORCEMENT PROTECTION

A. Bonding and Anti-corrosion Agent: Manufactured product that consists of an extended open time, water-insensitive epoxy adhesive/primer solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
   1. BASF Corporation, MasterProtect P 8100AP.
   2. Sika Corporation, Armatec 110 EpoCem.
   3. Simpson Strong-Tie FX-406.
   4. Approved equal.

2.03 SPRAY (OR TROWEL APPLIED) MORTAR SYSTEM (VERTICAL SURFACE REPAIR)

A. Mortar: NSF 61 compliant, One component, cementitious-based, fiber reinforced, shrinkage compensated, gray in color, with a minimum working time of 30-minutes.
   1. Sprayable and trowel-able, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of manufacturer's specialty liquid admixture.

B. Manufacturer and Products:
   1. A.W. Cook Cement Products, Inc, Silatec MSM Microsilica Mortar.
   2. BASF Corporation, MasterEmaco S 488CI with Concresive liquid (LPL).
   3. Euclid Chemical Company, Tamms Structural Mortar.
   4. Sika Corporation, SikaRepair 224 with Latex R.
   5. Approved equal.

2.04 POLYMER-MODIFIED REPAIR MORTAR (VERTICAL SURFACE REPAIR)

A. Mortar: NSF 61 compliant, two components, polymer-modified, cementitious based, chloride resistant, gray in color, minimum working time of 20 minutes.
   1. Hand applied, extremely low permeability, easy to use and requiring only the addition of water or manufacturer's specialty liquid admixture.

B. Manufacturers and Products:
   1. BASF Corporation
   2. Sika Corporation, SikaTop 123 Plus.
   3. Simpson Strong-Tie
   4. Approved equal.

2.05 POLYMER-MODIFIED REPAIR MORTAR (HORIZONTAL SURFACE REPAIR)

A. Mortar: NSF 61 compliant, two components, polymer-modified, cementitious based, gray in color, minimum working time of 20 minutes.
   1. Hand applied, extremely low permeability, easy to use and requiring only the addition of water or manufacturers specialty liquid admixture.

B. Manufacturers and Products:
   1. BASF Corporation
   2. Sika Corporation, SikaTop 122 Plus.

3. Simpson Strong-Tie
4. Approved equal.

2.06 EPOXY CRACK-INJECTION MATERIALS

A. Epoxy Crack-Injection Adhesive: ASTM C 881, bonding system, free of VOCs, NSF 61 Compliant
   1. Type IV at structural locations and where indicated or as directed by Engineer.
   2. Type I at other locations.

B. Manufacturers and Products:
   1. BASF Corporation
   2. Sika Corporation, Sikadur 31 Hi-Mod Gel
   3. Simpson Strong-Tie, ETI-LV.
   4. Approved equal.

2.07 HYDRO-ACTIVE: CRACK-INJECTION MATERIALS

A. Use an NSF-61 compliant product

B. Manufacturers and Products:
   1. 3M Specified Construction Products Department, Scotch-Seal Chemical Grout 5610 (Gel), hydrophilic, urethane.
   2. BASF Chemical Company, Masterinject 1230 IUG, hydrophobic polyurethane.
   3. de neef Construction Chemicals, Inc., Hydro Active Flex, hydrophobic polyurethane.
   4. Simpson Strong-Tie
   5. Approved equal.

2.08 CONCRETE JOINT SEALANT

A. Use an NSF-61 compliant polyurethane sealant designed for submerged conditions.

B. Manufacturers and Products:
   1. Sika Corporation, Sikaflex-1a or Sikaflex-2c
   2. Euclid Chemical Company, Tammsflex NS
   3. Approved equal.

PART 3 EXECUTION

3.01 CONCRETE REPAIR

A. Comply with manufacturers' written instructions for surface preparation, environmental conditions, product application, and product curing/protection requirements.

3.02 EXAMINATION

A. Notify Engineer seven days in advance of date when mockup areas of deteriorated concrete and deteriorated reinforcing bars will be cleaned for inspection and initial pull-off tensile bond strength test.
   1. Use chipping and/or bush hammers, abrasive blast, followed by pressure water blasting to remove debris, foreign material, and/or loose concrete from designated areas to be inspected and repaired. Verify depth of surface removal by sounding and pH testing.
   2. Follow surface preparation by vacuum and low-pressure water blasting to remove loose debris, foreign material, and/or concrete dust from areas to be inspected and repaired.
   3. Upon completion of surface cleaning, Engineer and Contractor shall observe surfaces and test results.

B. Perform visual surveys of the existing structure as Work progresses to detect hazards resulting from concrete repair Work. Notify Engineer of damage prior to making repairs.

3.03 PREPARATION

A. Ensure that supervisory personnel are on-site when concrete repair work begins and during its progress.

B. Protect persons, motor vehicles, surrounding surfaces of structure being repaired, and surrounding buildings and facilities from harm resulting from concrete repair Work.
   1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
   2. Use only proven protection methods appropriate to each area and surface being protected.
   3. Provide temporary barricades, barriers, and directional signage to exclude people from areas where concrete repair Work is being performed.
   4. Contain dust and debris generated by concrete repair Work in accordance with OSHA standards and prevent dust and debris from reaching public or adjacent surfaces.
   5. Protect slabs and other surfaces along haul routes from damage, wear, and staining.
   6. Protect adjacent surfaces and equipment by covering them with heavy polyethylene film and waterproof masking tape. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
   7. Neutralize and collect alkaline and acid wastes for legal disposal off property.
   8. Dispose of debris and runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

C. Prevent solids such as aggregate or cementitious material from migrating from the work area. Clean deposited sand or other materials resulting from concrete repair Work prior to reintroducing flow.

D. Preparation for Concrete Removal: Examine areas to be repaired to determine best methods to safely and effectively perform concrete repair Work. Examine adjacent areas to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed.
   1. Verify that affected utilities have been disconnected and capped.
   2. Inventory and record conditions of items to be removed for reinstallation or salvage.

E. Reinforcing-Bar Preparation: Remove rust from exposed reinforcing bars by abrasive blast cleaning in accordance with SSPC SP-6.
   1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, splice in new reinforcing bars and/or notify Engineer to determine appropriate repair method.

F. Surface Preparation for Concrete Surfaces:
   1. Remove delaminated and deteriorated concrete surface material by chipping, bush hammer, and/or pressure water blasting.
   2. Sweep and vacuum roughened surface to remove debris.
   3. Roughen surface of concrete to a minimum ¼-inch amplitude.
   4. Provide final cleaning of concrete to remove dirt, oils, films, and other materials detrimental to patching mortar.

3.04 EXTENT OF CONCRETE REMOVAL

A. Do not overload structural elements with debris.

B. Provide ¼-inch deep saw cut at perimeter of repair areas resulting in a defined repair area with a neat, rectangular, area.

C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.

D. Remove additional concrete where necessary to provide a depth of removal of at least ¼ inch over entire defined repair area.

E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least ¾-inch clearance around bar.

F. Test areas where concrete has been removed by tapping with hammer; remove additional concrete until unsound and dis-bonded concrete is completely removed. Provide a pH test of concrete surface to assure enough deteriorated concrete is removed to obtain a pH neutral surface.

G. Acceptable surface preparation must produce a concrete surface with a minimum pH of 9.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH

remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

H. Clean removal areas of loose concrete, dust, and debris.

I. Notify Engineer for observation of surface following cleaning and surface preparation in advance of surface mortar application. Allow at least 48 hours for observation by Engineer and/or inspection by Owner's testing agency for soundness testing, pull-off tensile bond strength testing, and pH testing.

J. Where required by Contract Documents, coordinate with Engineer and Owner's testing agency to provide up to six (6) smooth test areas for pull-off testing. Test areas are prepared by grinding smooth. The first test area shall be provided at the mockup area with the remaining five (5) areas to be selected after remaining surface preparation is completed.

3.05 REINFORCING PROTECTION APPLICATION

A. Where reinforcing bar is less than ½ exposed and there are no signs of corrosive products, do not apply anti-corrosion inhibitor.

B. Where reinforcing bar is ½ or more exposed or there are signs of corrosive products, remove concrete clear all around as specified above. Apply anti-corrosion inhibitor to the entire bar circumference.

C. Application of anti-corrosion inhibitor shall be made to reinforcing bars by stiff brush and according to manufacturer's instructions. Use care not to spill over or coat concrete and partially exposed reinforcing bar surfaces.

D. Apply anti-corrosion inhibitor to reinforcing bars in two coats. Allow first coat to dry two to three hours before applying second coat. Allow second coat to completely dry before placing repair mortar.

3.06 REINFORCING REPAIR

A. After preparation and prior to application of anti-corrosion inhibitor (where applicable), inspect existing reinforcing bars for deterioration. Notify Engineer where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars.

B. As directed by Engineer, add supplemental and/or replacement reinforcing.
   1. Install new reinforcing by tying to existing remaining reinforcing.
   2. Provide final touchup protection by re-application of anti-corrosion inhibitor to reinforcing surfaces, scratches, damaged areas, etc.

3.07 SURFACE MORTAR APPLICATION

A. Apply mortar according to manufacturer's written instructions.

B. For hand troweled or spray applied applications, work material firmly into the sides and bottom of repair area. Apply a scrub coat prior to full depth application. Build up prepared areas in multiple lifts as required by product manufacturer limitations.

C. For hand troweled or spray applied applications, follow manufacturer's recommendations for maximum lift thickness, additional surface preparation, and subsequent reapplication time.

D. Finish surface to match existing adjacent concrete surfaces and/or as required per coating manufacture's recommendations.

E. Moist cure mortar repair for a minimum of 5-days or in accordance with manufacturer's recommendations.

F. Notify Engineer for observation after repair mortar has been applied at the initial mockup area and after the repair has cured. Notify Engineer again at intervals specified or as subsequent repair mortar is applied and cured. Once scheduled, allow at least 48 hours for observation by Engineer and/or inspection by Owner's testing agency for pull-off tensile bond strength testing.

G. Coordinate with Engineer and Owner's testing lab to provide up to six (6) smooth test areas for pull-off testing at the completed mortar repair areas. Test areas shall be prepared by Contractor by grinding smooth. The first completed repair area shall be provided at the mockup area with the remaining five (5) areas to be selected after the mortar repair application is completed.

H. Contractor to provide follow up repairs to pull-off test areas.

3.08 EPOXY CRACK INJECTION

A. Expose identified cracks by lightly grinding along length of crack. Clean crack and adjacent areas with oil-free compressed air or low-pressure water to remove loose particles. Do not use acids or corrosives for cleaning. Notify Engineer for observation of crack repair areas prior to epoxy crack injection. Allow at least 48 hours advance notice for observation by Engineer.

B. Apply surface seal in accordance with Manufacturer's instructions to designated crack face prior to injection to prevent escape of injection epoxy.

C. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive. Seal entire crack length and allow to cure prior to injection.

D. Injection Procedure: Store epoxy at minimum of 70 °F.
   1. Start injection into each crack at lowest elevation entry port.
   2. Continue injection at first port until adhesive begins to flow out of next higher port.
   3. Plug first port and start injection at second port until adhesive flows from next port.
   4. Inject entire crack with same sequence.

E. Finishing Procedure:
   1. Cure epoxy adhesive after cracks have been filled to allow surface seal removal without draining or runback of epoxy material from cracks.
   2. Remove surface seal from cured injection adhesive.

3. Indentations or protrusions caused by placement of entry ports shall be filled with surface mortar or ground smooth with the adjacent surface.
4. Remove surface seal material and injection adhesive from concrete surfaces.

3.09 HYDRO-ACTIVE CRACK INJECTION

A. For Cracks, Wet and/or Leaking – repair utilizing a low viscosity, hydrophobic, closed cell polyurethane foam injection system.

B. Lightly grind crack surface as needed to remove efflorescence and to expose/open up face of the crack.

C. Starting 6 inches away from crack, drill injection holes at 45 degrees to intersect crack at a minimum of 6 inches deep from the crack surface.

D. Provide temporary entry ports in these drilled holes spaced 12 to 18 inches or as required to allow movement of fluid between ports. Provide temporary paste-over seal at concrete surface to prevent seepage of injected material.

E. Inject water into crack to flush out crack and to remove dirt, dust, and contaminants. Inject urethane foam with accelerating catalyst as required after the water flush.

F. Inject material into prepared ports under pressure using automated equipment that is appropriate for this application.

G. Start injection at the lowest elevation entry port. Continue injection until repair material appears in adjacent entry port. Repeat this process and continue from port to port until entire crack is filled.

H. Remove surface paste-over seal and excess adhesive by grinding or other approved method.

3.10 CONCRETE JOINTS (CONSTRUCTION AND EXPANSION)

A. Remove old sealant by mechanical means. Do not use solvents.

B. Abrasive blast to clean previously sealed concrete joint surfaces.

C. Install backer rod or tape to control sealant depth as recommended by manufacturer.

D. Apply sealant, tool, and cure as recommended by manufacturer.

3.11 FIELD QUALITY CONTROL

A. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives to provide Project-site training and inspections to observe progress and quality of Work.

B. Manufacturer’s factory-authorized services representatives should also be available for consultation and to provide on-site assistance when requested by Contractor and/or Engineer.

C. Provide manufacturer’s test and inspection reports to Engineer for record.

D. Coordinate with Engineer and Owner's testing agency for spot verification of substrate soundness, surface pH, and pull-off testing.

END OF SECTION

SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 DESCRIPTION

A. Formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. References:

1. The references listed below are part of this section. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict, the requirements of this section shall prevail.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.5	Specifications for Environmental Concrete Structures
National Institute of Standards - PS1	Construction and Industrial Plywood

B. Design – General:

1. Provide design of formwork, shoring and reshoring systems by the Contractor's Professional Engineer currently registered in the State of Utah.
2. Design, engineering, and construction of formwork, shoring, and reshoring systems is the responsibility of the Contractor.
3. Develop a procedure and schedule for removal of shores (and installation of reshores).
4. Structural record calculations, signed and sealed by the Contractor's Engineer, are required to prove that all portions of the structure, in combination with the remaining forming and shoring systems, have sufficient strength to safely support their own weight plus the loads placed thereon.
5. When developing procedures, schedules, and structural calculations; consider the structural system that exists, effects of imposed loads, and the strength of concrete at each stage of construction.

C. Design Criteria:

1. Design formwork in accordance with ACI 301 and ACI 318 for building structures and ACI 350 and 350.5 for environmental structures to provide concrete finishes as specified in Section 03 30 00.
2. Design systems for full height of wet concrete pressure.
3. Design formwork to limit maximum deflection of form facing materials, as reflected in concrete surfaces exposed to view, to 1/240 of span.

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturer's product data with installation instructions:
      a. Form materials.
      b. Form ties (with waterstops).
      c. Form release compound.
      d. Void forms.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Letter of certification:
      a. Stating that formwork has been designed in accordance with this specification and referenced documents, sealed and stamped by the Contractor's registered design Engineer.

PART 2 PRODUCTS

2.01 FORMS

A. Wood Forms:
   1. Provide new and unused exterior grade plywood panels manufactured in accordance with American Plywood Association (APA) and bearing the trademark of that group.
      a. Forms for concrete surfaces exposed to view: use APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4".
      b. Forms for other concrete surfaces: use APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch.
   2. When approved, plywood may be reused.

B. Metal Forms:
   1. Do not use aluminum. Provide forms free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

A. Form ties shall be commercially fabricated for use in form construction. Fabricated so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Cone on ends shall be 3/4 inch to 1 inch diameter. Provide embedded portion of tie not less than 1 1/2 inch from face of concrete after cone ends have been removed. Provide ties with integral waterstops at water-retaining and below grade structures.

B. Tapered through-bolts may be used when approved. Use 1-inch minimum diameter at the smallest end. Fill tapered tie holes after cleaning to produce watertight construction. Use a mechanical waterstop plug near the center of the wall and fill each side with non-shrink cement grout. Mechanical waterstop plug shall be Greenstreak Group, Inc. "X-Plug"; or equal.

2.03 FORM RELEASE COMPOUND

A. Coat form surfaces in contact with concrete using a non-staining, non-residual, water based, bond-breaking form coating. Use NSF 61 approved form release agents in potable water containment structures.

PART 3 EXECUTION

3.01 PREPARATION

A. Cover surface of forms with form release compound prior to form installation in accordance with manufacturer's recommendations.

B. Do not permit excess form coating material to stand in puddles on forms or hardened concrete surfaces against which fresh concrete is to be placed.

C. Clean surfaces of forms, reinforcing steel and other embedded items of accumulated mortar, grout, or other foreign materials from previous concreting or construction activities before concrete is placed.

3.02 FORMWORK CONSTRUCTION

A. Form vertical surfaces of cast-in-place concrete including sides of footings.

B. Construct and place forms so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Brace or tie forms together to maintain position and shape under the load of freshly-placed concrete.

C. Tighten forms to prevent leakage.

D. Provide temporary openings(windows) at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

E. Provide temporary openings to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height, spaced no more than 8 feet on center measured horizontally and vertically.

F. Place a 3/4-inch chamfer strip at exposed to view corners of formed surfaces.

G. At construction joints, overlap hardened concrete surface by at least 1 inch. Brace forms against hardened concrete to prevent movement, offsets, or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place forms at architectural lines, control joints, or at other inconspicuous lines.

H. Where circular sections are formed using flat faced materials, use flat form lengths not exceeding 2 feet wide and the resulting deflection angles at the joints is not greater than 3-1/2 degrees.

I. Construct wood forms for openings to facilitate loosening. Anchor forms so that movement of any part of the formwork system is prevented during concrete placement.

J. At platforms constructed to move equipment over in-place reinforcement, provide beams, struts, and/or legs, supported directly on formwork or other structural members without resting on reinforcing steel.

K. Provide a positive means of adjustment (wedges or jacks) at shores and struts to take up settlement during concrete placement. Brace forms against lateral deflection. Fasten in-place wedges and shims used for final adjustment of forms prior to concrete placement.

L. Place tapered through-bolt form ties with the larger end on the side of the structure in contact with liquid.

3.03 TOLERANCES

A. Install formwork with tolerances in accordance with ACI 117 and the following (the more stringent requirement controls):

1. Install formwork in accordance with manufacturer's written instructions.
2. Vertical surface tolerance from plumb; walls, columns, piers, and risers:

   ± 1/2 inch for entire height

   ± 1/4 inch in any 10 feet of height
3. Vertical surface tolerance from plumb; exposed wall corners, end columns, control-joint grooves, and other exposed to view vertical lines:

   ± 1/2 inch for entire height

   ± 1/4 inch in any 20 feet of height
4. Horizontal variation from level or from grade; top of slabs, slab soffits, ceilings, and beam soffits, measured before removal of supporting shores:

   ± 3/4 inch for entire length

   ± 3/8 inch for any bay or 20 foot length

   ± 1/4 inch in any 10 feet of length
5. Horizontal variation from level or from grade; exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view horizontal lines:

   ± 1/2 inch for entire length

   ± 1/4 inch in any 20 feet of length.
6. Plan position variation; columns, walls, and partitions:

   ± 3/4 inch for entire length

   ± 3/8 inch for any bay or 20 foot length
7. Plan location and size; sleeves, floor openings, walls, wall openings, beams, and columns:

   ± 1/2 inch
8. Cross sectional dimensions; columns and beams and thickness of slabs and walls:

   ± 3/8 inch
9. Plan dimensions; footings and foundations:

   minus 1/2 inch

   + 2 inches
10. Misplacement or eccentricity; footings and foundations:

2 percent of footing width in direction of misplacement

not more than 2 inches

11. Thickness; footings and foundation:

    minus 5 percent

    no limit on the maximum increase except that which may interfere with other construction.

12. Step variance in flight of stairs:

    Rise $\pm$ 1/16 inch

    Tread from level $\pm$ 1/8 inch

B. Use control points and benchmarks for reference purposes to check tolerances. Establish and maintain reference points in an undisturbed condition until final completion and acceptance of the work.

C. Regardless of tolerances listed, no portion of a structure shall extend beyond the legal boundary of work site.

D. Camber formwork to compensate for anticipated deflections in formwork under wet load of concrete. Adjust camber to maintain above specified tolerances in hardened concrete after forms and shoring are removed.

3.04 REMOVAL OF FORMS

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure in combination with remaining forming and shoring systems has sufficient strength to safely support its weight and loads placed thereon.

B. If forms are loosened and not removed, proceed same day with wet curing operations to soak surfaces of concrete where forms are loosened. When wet curing is not practical or not planned, loosen, remove, and start approved curing procedures on the same day.

C. When required for concrete curing in hot weather, required for repair of surface defects, or when required for finishing at an early age; remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

D. Remove top forms on sloping surfaces as soon as concrete has attained sufficient stiffness to prevent sagging. Make repairs or finishing treatment on such sloping surfaces immediately after form removal.

E. Remove wood forms for wall openings as soon as this can be accomplished without damage to concrete.

F. Remove formwork from columns, walls, sides of beams, and other parts not supporting weight of concrete as soon as concrete has hardened sufficiently to resist damage from removal.

G. When shores and supports are so arranged such that non-load-carrying form facing material can be removed without loosening or disturbing other shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

H. In all cases, proceed with curing same day as form removal.

I. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.

3.05 RESHORING

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure, in combination with remaining forming and shoring systems, has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads are permitted on the new construction.

C. During reshoring, do not subject concrete in structural members to combined dead and construction loads in excess of loads that the structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete, but in no case later than the end of working day on which stripping occurs.

E. Place reshores to carry their required loads without overstressing.

F. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength specified by the formwork engineer's structural calculations and verified by field cured test cylinders or other approved method.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Reinforcing steel for use in reinforced concrete.

1.02 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete
ACI SP-66	ACI Detailing Manual
ASTM A615	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
AWS D1.4	Structural Welding Code - Reinforcing Steel
CRSI-PRB	Placing Reinforcing Bars
CRSI-MSP	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.

5. Manufacturer and type of proprietary reinforcing steel splices. Submit a current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used.
6. Qualifications of welding operators, welding processes and procedures.
7. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. Shop drawings shall not be prepared by reproducing the plans and details indicated on the contract drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

1.04 DELIVERY, STORAGE AND HANDLING

A. Ship reinforcing steel to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.

PART 2 PRODUCTS

2.01 BAR REINFORCEMENT

A. Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706. Where specified, reinforcing steel shall be epoxy-coated in conformance with ASTM A775.

B. Reinforcing steel bars in structural elements designated on the design drawings as "special moment frames" and "special shear walls" shall be ASTM A706. ASTM A615 Grade 60 reinforcement may be used if the following requirements are met:
   1. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 psi.
   2. The ratio of the actual tensile strength to the actual yield strength is not less than 1.25.

2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A1064.

2.03 WIRE AND PLAIN BARS

A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A1064.

2.04 SMOOTH DOWEL BARS

A. Smooth dowel bars shall conform to ASTM A615, Grade 60, with a metal end cap at the greased or sliding end to allow longitudinal movement.

2.05 EPOXY COATED BARS

A. Epoxy coated bars shall conform to ASTM A775 and ASTM A884.

2.06 EPOXY COATED REINFORCING STEEL BAR PATCHING MATERIAL

A. Epoxy coated reinforcing steel bar patching material shall be compatible with coating material, inert in concrete, obtained from manufacturer of the epoxy resin used to coat the reinforcing steel bars and meet the requirements of ASTM A775.

2.07 REINFORCING STEEL MECHANICAL SPLICES

A. Reinforcing steel mechanical splices shall be a positive connecting threaded type mechanical splice system manufactured by Erico, Inc., Dayton Superior, Williams Form Engineering Company, or approved equal.

B. Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Where splices at the face of wall are shown or approved, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

C. Type 2 mechanical splices shall meet the requirements for a Type 1 mechanical splice, plus develop the ASTM specified tensile strength of the reinforcement. Type 2 mechanical splices shall be provided at locations specifically noted on the design drawings.

2.08 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.09 BAR SUPPORTS

A. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI-MSP and placed in accordance with CRSI-PRB. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.

B. Provide precast concrete blocks, four inches square in plan, with embedded tie wires (wire dobies) as specified by CRSI 1 MSP for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

C. Provide stainless steel or plastic protected plain steel supports for other work.

2.10 FABRICATION:

A. Fabricate reinforcing steel bars in accordance with ACI 315 and the following tolerances:
   1. Sheared lengths: +/-1 inch.
   2. Overall dimensions of stirrups, ties, and spirals: +/-1/2 inch.
   3. All other bends: +0 inch, -1/2 inch
   4. Minimum diameter of bends of reinforcing steel bars: Per ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT TOLERANCE

A. Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:
   1. Reinforcing steel bar clear distance to formed surfaces shall be within +/-1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
   2. Reinforcing steel top bars in slabs and beams shall be placed +/-1/4 inch of specified depth in members 8 inches deep or less and -1/4", +1/2 inch of specified depth in members greater than 8 inches deep.
   3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.
   4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 1/2 inches or 1.5 times the reinforcing steel bar diameter for columns.
   5. Beam and slab reinforcing steel bars shall be threaded through column vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

3.02 CONCRETE COVER

A. Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:
   1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.
   2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.
   3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.
   4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

3.03 SPLICING

A. Reinforcing steel splicing shall conform to the following:
   1. Use Class B splice lengths in accordance with ACI 318 for all reinforcing steel bars unless shown otherwise on the drawings.

2. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.
3. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Owner's Representative. Mechanical proprietary splice connections may be used when approved by the Owner's Representative or as indicated on the drawings.
4. Welding of reinforcing steel bars is not allowed unless approved by the Owner's Representative.

3.04 CLEANING

A. Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

3.05 PLACEMENT

A. Reinforcing steel bar placement shall conform to the following:
   1. Uncoated reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.
   2. Fasten coated reinforcing steel bars together to prevent displacement. Use plastic or nylon ties to hold the coated reinforcing steel bars rigidly in place. Support coated reinforcing steel bars with plastic or plastic coated chairs, runners, bolsters, spacers and supports as required.
   3. Support reinforcing steel bars over cardboard void forms by means of concrete supports which will not puncture or damage the void forms nor impair the strength of the concrete member.
   4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Place spacer reinforcing steel bars at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
   5. Extend reinforcement to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
   6. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Owner's Representative.
   7. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
   8. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.

9. Bars with kinks or with bends not shown shall not be used.
10. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Owner's Representative. Bars shall not be welded at the bend.

3.06 REPAIR OF EPOXY COATING

A. Epoxy coating damage need not be repaired in cases where the damaged area is 0.1 square inch or smaller. Repair all damaged areas larger than 0.1 square inch in conformance with ASTM A775.

3.07 FIELD QUALITY CONTROL

A. Field quality control shall include the following:
   1. Notify the Owner's Representative whenever the specified clearances between the reinforcing steel bars cannot be met. The concrete shall not be placed until the Contractor submits a solution to the congestion problem and it has been approved by the Owner's Representative.
   2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in this section. The Engineer's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the Owner's Representative.
   3. Coated reinforcing steel bars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating. The Owner's Representative may defer final inspection of the coated reinforcing steel bars until bar erection and handling is complete. Repair coated areas as directed by the Owner's Representative and completed prior to concrete placement.
   4. An independent laboratory shall be employed to review and approve Contractor welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete, which consists of providing material, mixing, transporting equipment, and labor for the proportioning, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete in the structure.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 60 00 Grouting
   2. Section 05 50 00 Metal Fabrications

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 211.1	Selecting Proportions for Normal, Heavy Weight and Mass Concrete
ACI 301	Specifications for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 214R	Guide to Evaluation of Strength Test Results in Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.1	Tightness Testing of Environmental Engineering Concrete Containment Structures
ACI 503.7	Crack Repair by Epoxy Injection
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Ready-Mixed Concrete
ASTM C117	Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Slump of Hydraulic Cement Concrete
ASTM C150	Portland Cement
ASTM C157	Length Change of Hardened Cement Mortar and Concrete

Reference	Title
ASTM C172	Sampling Freshly Mixed Concrete
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM C595	Blended Hydraulic Cements
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Slag Cement for use in Concrete and Mortars
ASTM C1059	Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1315	Liquid Membrane-Forming Compounds for Curing and Sealing Concrete
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate
ASTM C1602	Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Sampling Aggregates
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in Construction Inspection and/or Testing
CRD-C572	U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
4. Each proposed mix design showing:
    a. Expected strength at 7 and 28-days
    b. Slump, before and after introduction of high-range water-reducing admixture
    c. Water/cement ratio
    d. Weights and test results of the ingredients
    e. Aggregate gradation
    f. Test results of mix design prepared by an independent testing laboratory
    g. Shrinkage test results for liquid containing structures
    h. Other physical properties necessary to review each mix design for conformance with these specifications

5. Mix designs proposed shall be sealed by a Professional Engineer registered in the state where the project is located.
6. Product literature and technical data for aggregates, cement, and pozzolan.
7. Product literature, technical data, and dosage of proposed admixtures including, but not limited to, air entraining, water reducing, retarding, shrinkage reducing, etc.
8. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. Owner's Representative reserves the right to accept or reject such proposed methods.
9. Lift Drawings: Submit shop drawings for concrete placements on the project before on-site construction begins. The drawings shall be organized by structure and submitted as a complete set for the Engineer's review. The drawings shall be drawn to scale and show dimensions, forming details, and placement volumes. Show location of construction joints, details of surface preparation, scheduled finish, embedments, penetrations, openings, keyways, blockouts, bulkheads, etc. The drawings shall clearly show the placement sequence and will be accompanied by a schedule that shows the schedule dates for forming, placement, and stripping for each section of concrete placed within each structure.
10. Curing program description in sufficient detail to demonstrate that the Contractor will provide acceptable strength, finish, and crack control within the completed structure.
11. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, epoxy and chemical grout for crack injection.
12. Sample panels to demonstrate formed wall surface finishes as specified in Part 3.
13. Samples of concrete floor and slab finishes as specified in Part 3.
14. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

1.05 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of concrete work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspection of concrete is in addition to, not replacing, other inspections and quality control requirements specified herein. Where sampling and testing specified herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.
   3. Refer to Section 01 45 00 Quality Control, for Owner provided testing.

B. Quality Control By Contractor:
   1. Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329. The testing

laboratory shall sample and test concrete materials as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.

C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. Concrete Conference
   1. Contractor shall schedule and conduct a meeting to review the specification requirements and the proposed concrete design mixes, including procedures for producing proper concrete construction. Hold the meeting no later than 28 days after the Notice to Proceed.
   2. All parties involved in the concrete work shall be included to attend the conference, including the following: Contractor's representative, testing laboratory, concrete subcontractor, concrete supplier, Owner's Representative, and Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Cement:
   1. Store cement bags immediately upon receipt in a weatherproof structure as airtight as practicable. Elevate floor above ground to prevent absorption of moisture. Stack bags close together to reduce circulation of air but do not stack against outside walls. Stack to permit easy access for inspection and identification of each shipment.
   2. Transfer bulk cement to elevated airtight and weatherproof bins. At the time of use, cement shall be free flowing and free of lumps. Do not use cement which has been in storage longer than 6 months.

B. Aggregates:
   1. Store aggregates on areas covered with tightly laid wood planks, sheet metal, or other hard and clean surfaces in a manner that will preclude the inclusion of foreign material. Store aggregates of different sizes in separate piles. Build stock piles of coarse aggregate in horizontal layers exceeding 4 feet in depth to minimize segregation. Remix segregated aggregates to conform to the grading requirements.

C. Admixtures:
   1. Store admixtures to prevent damage. Do not use air-entraining admixture which has been in storage for longer than 6 months or has been frozen.

D. Pozzolan:
   1. Deliver and store pozzolan in the same manner as cement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement shall be ASTM C150, Type V, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.

2. If low alkali cement is not available, aggregates shall show an expansion of less than 0.1% when tested in accordance with ASTM C1260 or ASTM C1567 concrete mix test results shall be submitted verifying that the aggregates are not reactive per the criteria in this standard. ASTM C1260 and ASTM C1567 results shall be no older than 1 year.
3. Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.
4. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Change of Materials paragraph below.

B. Ground granulated blast-furnace slag (GGBFS), if used in conjunction with portland cement, shall be per ASTM C989.

C. Aggregates:
   1. General:
      a. Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.
      b. Check aggregates for alkali-silica reactive constituents per ASTM C1260. Aggregate shall have less than 0.1% expansion when tested in accordance with ASTM C1260. Aggregates having 0.1% or greater expansion may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 days. Test results shall be no older than 1 year.
      c. Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. Establish the final combined aggregate gradation during mix design.
      d. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Change of Materials paragraph below.
   2. Fine Aggregate:
      a. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.
      b. Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

      c. Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70 percent

3. Coarse Aggregate:
    a. Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 3 for Class Designation 5S. Gradation of each coarse aggregate size specified shall conform to ASTM C33, Table 2.
    b. Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

D. Pozzolan:
1. Pozzolan shall be Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Change of Materials paragraph below.
2. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.
3. Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

E. Admixtures:
1. General:
    a. Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Use admixtures in accordance with the manufacturer's recommendations and add separately to the concrete mix. Water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with requirements specified in Part 3.
2. Water Reducing Admixtures:
    a. Conform to ASTM C494, Type A. Acceptable products include: BASF “MasterPozzolith 322”; SIKA Chemical Corp. “Plastocrete 161”; Euclid Chemical Co. “Eucon WR 91”; or approved equal.
3. Water Reducing and Retarding Admixtures:
    a. Conform to ASTM C494, Type D. Acceptable products include: BASF “MasterPozzolith 80”; Sika Chemical Corp. “Plastiment”; Euclid Chemical Co. “Eucon Retarder 75”; or approved equal.
4. High Range Water Reducing (Superplasticizing) Admixtures:
    a. Conform to ASTM C494, Type F. Acceptable products include: BASF “MasterGlenium” Series; Sika Chemical Corp. “Viscocrete 2100” or “Viscocrete 2110” (Hot Weather) or “Viscocrete 6100” (Cold Weather); Euclid Chemical Co. “Eucon 37”; W.R. Grace “ADVA 195”; or approved equal.
5. High Range Water Reducing And Retarding Admixtures:

a. Conform to ASTM C494, Type G. Acceptable products include: W.R. Grace “Daracem 100”; Sika Chemical Corp. “Sikaplast 200” ; Euclid Chemical Co. “Eucon 537”; or approved equal.

6. Air Entraining Agent:
   a. Conform to ASTM C260 and produce air entrained concrete as specified in the Mix Proportioning table below. Acceptable products include: Sika Chemical Corp. “AEA-15”; Euclid Chemical Co. “AEA-92”; or approved equal.
7. Shrinkage Reducing Admixture:
   a. Select admixture for compatibility with air entrainment admixture and other ingredients in the concrete mix. Acceptable products include: BASF “Tetraguard AS20”; Grace “Eclipse 4500”; or approved equal.

F. Water:
1. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. Change of Materials:
1. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the Engineer. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the Engineer before use in concrete.

2.02 CONCRETE CHARACTERISTICS

A. Mix Proportioning:
1. Concrete shall be normal weight concrete composed of cement, pozzolan, admixtures, aggregates, and water; proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. It is acceptable to substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan.
2. Provide concrete mix designs in accordance with the following guidelines:

Concrete class	Minimum[a] 28-day compressive strength, psi	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum cementitious materials content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Slump range[f] (inches)
B	3000	57 or 67	0.45	560	15-20[d]	4-6	3-5
C-1	4500	57 or 67	0.40	560	15-20	4-6	3-5
E[c]	2000	57	--	-	15-20[d]	Not Required	4-8

[a] *Determine compressive strength at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.*

[c] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[d] *Pozzolan use is optional for this class of concrete.*

[f] *Slump before addition of high range water reducing admixture (superplasticizer). Maximum slump after addition of high range water reducing admixture shall be 8".*

B. Use:

1. Provide concrete by class for the uses listed below.

Concrete class	Type of use
B	Non-structural concrete (sidewalks, curbs, pavers, etc.)
C-1	Typical cast-in-place structural concrete
E[a]	Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill

[a] *Contractor's option to use the same concrete mix for pipe encasement as the concrete slab above.*

C. Control Tests:

1. General:
   a. Select and adjust proportions of ingredients in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the Trial Mix Design method or Field Experience Data method. Do not place concrete prior to submittal and acceptance of proposed mix.
2. Trial Mix Design:
   a. Mixes verified by this method shall have the samples produced for testing, manufactured at the batch plant which will supply concrete to the project, using materials proposed for the Work and material combinations listed above. Testing, data, and reporting shall conform to ACI 318 and the following:
      1) Required compressive strength used as the basis for selecting concrete proportions (f'cr) shall be the specified concrete strength (f'c) + 1000 psi for specified concrete strengths less than 3,000 psi and f'c + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.
      2) Make at least three different trial mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing f'cr.
      3) Design trial mixtures to produce a slump within ¾ inch of the maximum specified and an air content within 0.5 percent of the maximum specified.
      4) For each w/cm ratio or cementitious materials content, cast and cure at least twelve standard test cylinders in accordance with ASTM C192. Four cylinders from each batch tested at age 7-days, 14-days, and 28-days or as required to comply with ACI 318.
      5) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.
      6) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce f'cr. This is the maximum w/cm ratio to be used unless a lower w/cm ratio is specified above.
3. Field Experience Data:
   a. When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use, Contractor may substitute use of

this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318, except as modified herein.

1) Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits:
    a) f'c as specified or up to 500 psi above
    b) w/cm ratio as specified or lower
    c) pozzolan content within 5 percent of that specified
    d) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary
    e) slump after introduction of admixtures +0/-1 inch.

b. Use of historical Field Experience Data does not allow modification of the project mix specifications herein without review and acceptance by the Engineer.

4. Shrinkage:
    a. Liquid containing structures using Class C-1 concrete mix are intended to be watertight. Provide test results for Class C-1 concrete mix meeting the following requirement: drying shrinkage limit of 0.04 percent in the laboratory at 35-days (7-days moist cure and 28-days drying) as tested in accordance with ASTM C157 and the following modifications:
        1) Wet cure specimens for a period of 7-days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.
        2) Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.
        3) Report results in accordance with ASTM C 157 at 0, 7, 14 & 28-days of drying.
    b. Concrete shall not be placed in the field prior to acceptance of the concrete mix. To meet the drying shrinkage limit, it is recommended that a shrinkage reducing admixture be considered for use in concrete for liquid containing structures.

2.03 WATERSTOPS

A. Polyvinyl Chloride (PVC):
    1. Manufacture PVC waterstops from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Use 6-inch flat center/ribbed sides/0.375 inch thick less waterstops in construction joints. Acceptable products include: Greenstreak Group, Inc. "Model 679"; Vinylex Waterstops and Accessories "Model R638"; or approved equal. Use 9 inch center-bulb/ribbed sides/0.375 inch thick waterstops in expansion joints. Acceptable products include: Greenstreak Group, Inc. "Model 696"; Vinylex Waterstops and Accessories Model "RLB938"; or approved equal.
    2. Use molded crosses, tees, and other shapes for changes of direction, intersections, and transitions or cut and splice as recommended by the manufacturer.

B. Expanding (Hydrophilic) Waterstops:
    1. Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include: Adeka Corporation "Ultra Seal MC-2010MN"; Greenstreak Group, Inc. "Hydrotite CJ-1020-2K"; or approved equal. These are

allowable for use only where indicated on the drawings or accepted in writing by the Engineer. Provide adhesive approved by the waterstop manufacturer plus concrete nails and fender washers to secure waterstop material in-place during concrete placement. The waterstop MUST be placed between two mats or curtains of steel reinforcement.

2. For limited cover applications or where only one mat or curtain of reinforcement is present, use Adeka Corporation “Ultra Seal KBA-1510FP”or approved equal.

2.04 SEALANTS AND JOINT FILLERS [NOT USED]

2.05 BONDING COMPOUNDS

A. Epoxy resin bonding compounds for use in wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use. Acceptable products include: BASF “MasterEmaco ADH 327RS” or “MasterEmaco ADH 1490”; Sika Chemical Corporation “Sikadur 32”; or approved equal.

B. Non-epoxy bonding compounds for use in dry areas for non-structural bonding or as noted on the drawings shall conform to ASTM C1059 Type II. Acceptable products include: Edoco “Burke Acrylic Bondcrete”; ChemMasters “Cretelox”; or approved equal.

C. Apply bonding compounds in accordance with the manufacturer’s instructions.

2.06 EPOXY FOR CRACK INJECTION

A. Use a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, epoxy-resin blend. Consistency as required to achieve complete penetration into cracks. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include: Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or approved equal.

B. Use epoxy injection for structural crack repairs except as noted below for non-structural cracks in liquid-containing concrete structures. The Engineer shall determine whether a crack is classified as structural or non-structural.

2.07 CHEMICAL GROUT FOR CRACK INJECTION

A. Use hydrophobic polyurethane grout at the Engineer's discretion as an alternative for sealing non-structural cracks in concrete structures intended to be watertight. Acceptable products include: DeNeef Construction Chemicals "Hydro Active Cut" and “Flex SLV PURe” or Sika Corporation “SikaFix HH Plus” and “SikaFix HH LV”; or approved equal.

2.08 CURING AND SEALING COMPOUNDS

A. Curing and sealing compounds shall be NSF-61 certified for use at a water treatment plant; acceptable products include Atlas Quantum-Cure NSF or approved equal.

B. Compound shall be clear and applied in accordance with the manufacturer’s instructions.

C. Curing and sealing compound shall be certified compliant with final finish system if applicable.

PART 3 EXECUTION

3.01 GENERAL

A. Use only truck-mixed, ready-mixed concrete conforming to ASTM C94. Proportion materials by weighing.

B. Introduce pozzolan into the mixer with cement and other components of the concrete mix; do not introduce pozzolan into a wet mixer ahead of other materials or with mixing water.

C. Introduce water at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified w/c ration and slump is not exceeded and the maximum total water per the approved mix design is not exceeded.

D. Arrange with the testing laboratory for inspection as required to comply with these specifications.

E. Deliver concrete to the site and complete discharge within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a Contractor proposed remedial action plan to be reviewed and accepted by the Owner's Representative.

3.02 CONVEYING AND PLACING CONCRETE

A. Convey concrete from the mixer to the forms in accordance with ACI 301. Remove concrete that has segregated in conveying from the site of the work.

B. Placing Concrete:
   1. General:
      a. Place concrete in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft.
   2. Placing Concrete By Pumping:
      a. Concrete placed by pumping is at Contractor's discretion and shall not be the cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.
      b. Measure slump at the hose discharge, except as follows: Initial slump testing in each placement shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.
      c. Measure air content at the hose discharge, except as follows: Initial air content testing shall occur at both the pumping unit inlet hopper and the hose discharge. Loss of air content shall be measured between the inlet hopper and the hose discharge. Increase the air content of the delivered concrete at the inlet hopper to provide the specified air content at the hose discharge. After these criteria have been satisfied, air content may be measured at the inlet hopper.
      d. Before starting each pumping operation, prime the pump and line with a cement slurry to lubricate the system. Waste cement slurry outside the forms. Equip hose

tip with a safety chain for recovery in case of hose blowout during pumping. Hose or accessories shall not remain in the freshly placed concrete.

e. Use tremie placing techniques and equipment for pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times. Concrete pumping shall not occur until Owner's Representative has verified equipment including the tremie plug. Should the discharge line become open, with zones empty of concrete, cease pumping and re-primed with tremie plug installed before continuing.

3. Placing Concrete In Hot Weather:
   a. In temperatures above 80 degrees F, place concrete in accordance with ACI 305.1.
4. Placing Concrete In Cold Weather:
   a. In temperatures below 45 degrees F, place concrete in accordance with ACI 306.1.

3.03 CONSOLIDATING CONCRETE:

A. Consolidate concrete in accordance with ACI 301. If evidence of inadequate consolidation is observed, concrete placement will be suspended until Contractor provides a revised plan to achieve proper consolidation.

3.04 CURING AND SEALING

A. General:
   1. Cure concrete using water, a clear membrane curing compound, or by a combination of both methods. Coordinate repairs or treatment of concrete surfaces so that interruption of curing will not be necessary.
   2. Maintain concrete surface temperature between 50 degrees F and 80 degrees F for at least 5 days. Cure concrete in hot weather (above 80 degrees F) in accordance with ACI 305.1. Cure concrete in cold weather (below 45 degrees F) in accordance with ACI 306.1.

B. Water Curing:
   1. Keep concrete continuously wet for a minimum of 10-days after placement. Absorptive mats or fabric may be used to retain moisture during the curing period.
   2. Use water curing in hot weather for liquid containment structures. Cover forms and keep moist. Loosen forms as soon as possible without damage to the concrete, and make provisions for curing water to run down inside them. During form removal, take care to provide continuously wet cover to newly exposed surfaces.

C. Curing Compound:
   1. When curing compound is allowed, apply it as soon as the concrete has set sufficiently so as not to be marred by the application or apply it immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall follow manufacturer's instructions. For liquid containing structures, apply curing compound at twice the manufacturer's recommended dosage rate, applied in two coats perpendicular to each other.

2. Do not use curing compound on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded In these cases, use water curing unless the curing compound is first removed or is compatible with the final finish covering.

3.05 PROTECTION

A. Protect concrete from injurious action by sun, rain, flowing water, frost, and mechanical means.

B. Loading green concrete is not permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing structures to the satisfaction of the Owner's Representative.

D. Arrangements for covering, insulating, heating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. General:
   1. Place concrete in each unit of construction continuously. Before new concrete is placed on or against concrete which has set, retighten forms and clean foreign matter from the surface of the set concrete. Provide waterstops as specified.

B. Construction:
   1. Form construction joints by producing a rough surface of exposed aggregates using a surface retardant; include joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, remove retarded surface mortar either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

C. Locations:
   1. Provide construction joint locations as follows:
      a. Cast walls exceeding 50 feet in length in panels not to exceed 30 feet in length. Cast adjoining panels only after 5-days have elapsed. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from a corner unless specifically detailed thus on the drawings.
      b. Locate joints in beams or girders at or near the quarter point between supports.
      c. Make joints in the members of a floor system at or near the quarterpoint of the span.
      d. Make joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs.

e. Cast slab panels in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, with maximum 1 ½ to 1 ratio of side lengths. Minimum lapsed time between placing adjacent panels shall be 3-days. The requirements for size of slab panel is waived if joints are located on the Drawings.

2. Vertical construction joints shall have edges grooved or beveled at faces exposed to view including interior faces of basins and tanks. Seal grooves subjected to wetting or weather with joint sealant.
3. Continue reinforcing steel through construction joints. Beams, girders, and floor slabs shall not be constructed over columns or walls until at least one day has elapsed to allow for initial shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder unless otherwise shown. Joints shall be perpendicular to the main reinforcement. Provide waterstops in construction joints as specified.

3.07 INSERTS AND EMBEDMENTS

A. Inserts:

1. Where pipes, castings, or conduits are to pass through structures, position in forms before placing concrete; or where shown on Drawings or approved by the Owner's Representative, provide openings in the concrete for subsequent insertion of such pipes, castings, or conduits. Provided waterstops and a slight flare in the form to facilitate grouting and permit the escape of entrained air during grouting.
2. Provide additional reinforcement around openings. Use non-shrink grout to infill around inserts.
3. Place horizontal conduits and pipes, in slabs and beams, between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318.
4. Conduits and pipes shall not run directly beneath a column or base plate.
5. Position conduit, pipe, dowels, and other ferrous items such that there will be a minimum of 2-inches clearance between said item and concrete reinforcement. Welding inserts to reinforcement is not permitted.
6. The outside diameter of conduit or pipe shall not exceed one-fourth the slab or beam thickness.

B. Embedments:

1. Gate frames, gate thimbles, special castings, channels, grating frames, or other miscellaneous metal parts to be embedded in concrete shall be secured in the forms prior to concrete placement.
2. Embed anchor bolts and inserts in concrete as shown. Provide inserts, anchors, or other bolts necessary for the attachment of piping, valves, metal parts, and equipment.
3. Provide nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent entry of concrete. Do not use continuous anchor slots or strips in concrete intended to be watertight.
4. Position operators or sleeves for gate or valve stems to clear reinforcing steel, conduit, and other embedments, and to align accurately with equipment.

3.08 EXPANSION JOINTS

A. Expansion joints shall be as shown. Do not extend reinforcement or other embedded metal items through expansion joints. Provide waterstops where indicated.

3.09 WATERSTOPS

A. Waterstops shall conform to ACI 301. Tie waterstops in position prior to placement of concrete to prevent movement and deformation.

B. Provide waterstops in construction and expansion joints as follows:
   1. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
   2. Wall and slab joints of tanks and channels subject to water pressure.
   3. Waterstops shall be provided for the full height of the walls.
   4. Provide at other locations shown on the Drawings.

C. Field splices shall be at straight sections using heat fused welded, butt splices only. Lapping of splices or joining by means other than heat fused welding is not allowed.

D. Install hydrophilic waterstops according to manufacturer's recommendations. Surfaces of concrete shall be prepared level/plumb and to the smoothness required by manufacturer. Grind surface as necessary. Provide bonding adhesive and concrete nails with fender washers to hold waterstop in position during concrete placement.

3.10 MODIFICATION OF EXISTING CONCRETE

A. General:
   1. Verify structural dimensions related to or controlled by previously constructed or existing structures prior to concrete work.

B. Cutting or Coring Concrete:
   1. Saw cut concrete to a depth of 1 inch to form straight outlines of concrete areas to be removed. Where reinforcement is exposed due to saw cutting or core drilling and no new material is to be placed on the cut surface, provide a protective epoxy coating to the entire cut surface.
   2. Coat surfaces of oversized openings with an epoxy bonding compound prior to re-finishing with profiling mortar to the required opening size.
   3. Grind existing joint edges to create a chamfer matching those used on adjacent construction.
   4. Investigate concrete to be drilled, cored, or sawcut to determine location of reinforcing steel. Locate penetrations to clear existing reinforcing steel. Where not possible to avoid reinforcing steel, consult the Engineer as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed.
   5. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be by the Contractor.

C. Joining New Concrete To Existing:

1. Existing concrete surfaces to be joined with new concrete shall be cleaned and roughened by abrasive blasting, bush hammering, or other method to achieve ¼-inch amplitude surface. Remove existing metalwork, embeds, or other interfering items. Coat existing surface with epoxy bonding compound prior to placement of new concrete.

D. Post-Installed Anchors and Dowels:
   1. Use non-destructive methods for locating reinforcement prior to drilling operations. For anchor and dowel locations that interfere with reinforcement, attempt to relocate to avoid drilling through the reinforcement if possible.
   2. For situations that do not allow relocation, cutting of reinforcement for installation is subject to the following:
      a. Prior to drilling through reinforcement, the Contractor shall consult the Owner's Representative or Engineer.
      b. Drill holes with a hammer drill and carbide bit (core drilled holes are not allowed), followed by brushing and air-cleaning with oil-free compressed air.
      c. Holes drilled through reinforcement must be in compliance with adhesive anchor assumptions for roughened hole surface typical of a hammer drill and carbide bit. No smooth hole surfaces are allowed.
      d. Do not cut slab rebar within 24 inches of a supporting wall, column, or an opening in the slab.
      e. No cutting of rebar is allowed in the middle third of slab spans for anchors with diameters equal to or greater than 3/4 inch.
      f. Maximum of two rebar may be cut in any 10 foot width of slab.
      g. Maximum of two rebar may be cut within any 10 foot width of concrete wall.
      h. Maximum of one rebar may be cut within any 8 foot width of CMU wall.
   3. For anchors that cannot be moved and that conflict with the above requirements, consult Engineer for direction. It is not acceptable to cut reinforcement in beams, columns, precast members, or stairs.
   4. Use a pre-manufactured, self-mixing, injectable, two-component, epoxy adhesive, as per Section 03 60 00. Follow manufacturer's recommendations and ICC Evaluation Report for installation.

E. Waterstops:
   1. Where a waterstop between new and existing concrete is required, install either a hydrophilic waterstop or a retrofit waterstop as indicated.

3.11 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
   1. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete in accordance with ACI 301. Clean areas to be repaired. Cut and chip out honeycombed or otherwise defective areas to solid concrete, to a depth of at least 1-inch. If defective area includes exposed reinforcing steel, correct by removing concrete a minimum of 1-inch beyond the reinforcing. Make edges of the cut perpendicular to the surface of the concrete in a neat rectangular pattern.
   2. Joints shall be grooved to a radius or bevel of ¾-inch depth.

3. Finish patches on exposed surfaces to match and blend with adjoining work. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions.

B. Formed Surface Finishes:
   1. Finish A - Grout Rubbed Finish
      a. After repair of surface defects, apply a grout rubbed finish in accordance with ACI 301 except that all form fins and other protrusions shall be completely removed. Lightly sandblast surfaces prior to sacking. Sandblasting shall occur after the specified curing period.
      b. Add a PVA bonding compound to the mix water used in sacking mortar; as recommended by the manufacturer.
      c. Provide Finish A at uncoated surfaces of stair wells, interior surfaces of equipment rooms, galleries, tunnels, operations areas, exposed channels and tanks from 1 foot below minimum water surfaces and up, and at permanently exposed vertical and sloped surfaces such as pipe chases.
      d. Do not provide Finish A at concrete surfaces receiving a coating.
   2. Finish B - Smooth Surface Finish
      a. Initial surface preparation is the same as Finish A; repair surface defects and remove all form fins.
   3. Finish C - Rough Form Finish
      a. Repair surface defects and imperfections greater than 3/8 inch in any dimension. Remove form fins and protrusions down to less than 3/8 inch projection.
      b. Provide Finish C or smoother, for interior surfaces of wet wells, tanks, and channels; from 1 foot below minimum water surface and down.
      c. Also apply Finish C to unoccupied interior areas not otherwise specified.
   4. Finish D – Unfinished Surface
      a. Repair surface defects and otherwise leave the surfaces as they come from the forms, except plug tie holes and repair or remove defects greater than 1/2 inch in any dimension.

C. Sample Of Formed Surface Finish A:
   1. Provide a sample concrete panel, minimum 4 feet by 4 feet; representative of formed surface Finish A. The panel shall be representative of the workmanship and finish required, including repair of defects, filling of tie holes, sandblasting, and rubbing.
   2. The sample shall be approved by the Owner's Representative prior to the start of production work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.12 SLAB FINISHES

A. General:
   1. The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Do not use dry cement on new concrete surfaces to absorb excess moisture. Round edges to a radius of 1/2 inch.

2. Slope floors to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Restrict use of floor drains with only locally depressed slabs to locations specifically noted.
3. Immediately after final finish is applied, the surface shall be cured and protected as specified in Curing, Sealing, and Protection paragraphs above.
4. Where finish is not specified, floor slabs shall receive a Steel Trowel Finish.

B. Float Finish:
1. Perform floating with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently. Float as required to meet tolerance requirements of ACI 117 for a conventional surface.
2. Floating shall close cracks and checks plus compact and smooth the surface. Refloat the slab to a uniform texture.
3. Apply float finish to surfaces of channels, tank bottom slabs, tops of footings, and surfaces to receive insulation or roofing.

C. Steel Trowel Finish:
1. Float the concrete surface as indicated above and then trowel in accordance with ACI 301.
2. Provide Steel Trowel Finish on floors and walking surfaces unless specified otherwise.

D. Broom Finish:
1. Float the concrete surface as indicated above, then immediately give the concrete a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301.
2. Provide a Broom Finish for walks, top of tank walls, slabs-on-grade exposed to atmosphere, and where otherwise indicated.

E. Samples Of Concrete Slab Finishes:
1. Provide a sample concrete slab, minimum 4 feet by 4 feet, representative of workmanship and each specified finish.
2. Samples shall be approved by the Owner's Representative prior to the start of production work. The samples shall be on display at the job site, and finished surfaces shall match samples.

3.13 RELATED SURFACES

A. Finishing of Unformed Surfaces:
1. Adjacent Unformed Surfaces:
a. Tops of walls, buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be Float Finished to a texture reasonably consistent with that of the adjacent formed surface.
b. Continue final treatment of formed surface uniformly across the top of the unformed surface.
2. Pavements and Sidewalks:

a. The surface of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall be Float Finished followed by a Broom Finish.
b. Round edges and expansion joints to a radius of 1/2 inch. Control joints shall be grooved or sawcut to a minimum depth of 1/4 the slab thickness.

3.14 FIELD SAMPLING AND TESTS

A. General:
1. Field sampling and tests shall be performed by an independent testing laboratory. Samples of aggregates and concrete will be obtained at such times to represent the quality of the materials and work throughout the project.
2. The laboratory shall provide necessary labor, materials and facilities for sampling aggregate and for casting, handling, and initially storing the concrete samples at the work site.
3. The minimum number of samples and tests are specified in Testing paragraph below.

B. Sampling:
1. Aggregates:
a. General:
1) Sample fine and coarse aggregates in accordance with ASTM D75 not less than 30 days prior to the use of such aggregates in the work.
2) Take samples at the discharge gates of the bins feeding the weigh hopper. Repeat sampling when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found.
3) Aggregate samples shall be tagged and their sources identified.
b. Coarse Aggregate:
1) Take a sample weighing between 50 and 60 pounds after the batch plant is brought up to full operation.
2) Take samples to obtain a uniform cross section, accurately representing the materials on the belt or in the bins for sieve analysis.
c. Fine Aggregate:
1) Take samples as specified for coarse aggregate.
2) Take samples of sand when the sand is moist for sieve analysis and specific gravity tests.
2. Concrete:
a. Take samples of plastic concrete in accordance with ASTM C172.
b. Take samples at the hopper of mixing equipment or transit mix truck, except as noted in the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

C. Testing:

1. Aggregate:
    a. A minimum of one test of coarse aggregate per 400 cubic yards of concrete used and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent.
    b. A maximum of one test per day of each aggregate is required.
    c. Repeat of the entire concrete mix design test program is required before source changes will be accepted.
2. Concrete:
    a. Strength Tests:
        1) The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 x 8 inch or 6 x 12 inch.
        2) Concrete samples shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less, or for each 5,000 square feet of slab or wall surface area placed per day. Provide additional cylinders when an error in batching is suspected. Each set of cylinders are cast from material taken from a single load of concrete.
        3) Casting, handling and curing of cylinders shall be in accordance with ASTM C31. For the first 24 hours after casting, keep cylinders moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the testing laboratory will transport the cylinders to their laboratory.
        4) Testing of specimens for compressive strength shall be in accordance with ASTM C39. Each test shall consist of two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) specimens. Test at the end of 7 days and at the end of 28 days. The remaining cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification.
        5) A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8). If one cylinder shows evidence of low strength due to improper sampling, casting, handling, or curing, the result of the remaining cylinders may be used if approved by the Owner's Representative.
        6) The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength. Not more than 10 percent of the individual strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.
        7) Provide certified reports of the test results directly to the Owner's Representative and the Engineer. Test reports shall include sufficient information to identify the mix used, the stationing or location of the

concrete placement, and the quantity placed. Slump, water/cement ratio, air content, temperature of concrete, and ambient temperature shall be noted.

8) The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in accordance with ACI 214R. Quality control charts shall be maintained throughout the entire project and shall be available for the Owner's Representative's inspection at any time.

9) If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Report changes and adjustments in writing to the Owner's Representative.

10) If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Engineer. Costs of such tests and/or analysis shall be borne by the Contractor.

b. Tests for Consistency of Concrete:

1) Measure slump in accordance with ASTM C143. Take samples for slump determination from concrete during placement. Tests shall be made at the beginning of concrete placement operation, whenever test cylinders are cast, and at subsequent intervals to ensure that the specification requirements are met.

2) For pumped concrete, measure slump in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

3) When high range water reducer is added at the site, slump tests shall be taken before and after addition of the admixture.

c. Tests for Temperature and Air Content:

1) Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Perform temperature tests whenever test cylinders are cast.

2) Measure air content in accordance with ASTM C231 whenever test cylinders are cast. For pumped concrete, measure air content in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

D. Final Laboratory Report:

1. The testing laboratory shall provide a final report at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure.
2. Include final quality control charts for compressive strength tests for classes of concrete specified in each major structure. Also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.15 REPAIR OF DAMAGED AND CRACKED CONCRETE:

A. Acceptance Of Concrete:
   1. Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet these requirements shall be repaired, as approved by the Engineer, to bring the concrete into compliance. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Engineer.
   2. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Remove and replace rejected concrete work.
   3. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. Repair Methods:
   1. Damaged/defective concrete or concrete with crack widths exceeding 0.004 inches at liquid-containing and conveying structures or crack widths exceeding 0.006 inches for other structures shall be repaired by one of the following methods (only the Engineer may determine that a defect or crack does not require repair):
      a. Perform watertightness testing and repair as needed to meet leakage criteria in this specification even when liquid-containing and conveying structures meet the crack width criteria defined above.
      b. Damaged or defective concrete includes surface defects, honeycomb, rock pockets, indentations greater than 3/16 inch, spalls, chips, air bubbles greater than 1/2 inch diameter, pinholes, bugholes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, projections, form popouts, texture irregularities, and stains or other color variation that cannot be removed by cleaning.
         1) Damaged or defective concrete is repaired according to procedures outlined above under finish requirements, Repair of Surface Defects.
   2. Crack Repair Method 1:
      a. Fill the joint or crack by drilling holes to the affected area (following the product manufacturer's details), install injection ports, and force epoxy or chemical grout (expanding urethane) into the joint under pressure.
      b. Material type and repair procedures shall be approved by Engineer.
      c. After injection and curing; ports, sealing mix, and surface shall be cleaned and worked to match the adjacent specified finish.
   3. Crack Repair Method 2:
      a. Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations.
      b. At a minimum, prepare surface to be clean and dry with no visible detrimental material in cracks to be filled. Conform to temperature limitations of epoxy. Clean and refinish to match adjacent surfaces.
   4. Crack Repair Method 3:
      a. Cut a bevel groove 3/8 to 1/2 inch in width and depth, use backer rod or tape, and fill with sealant in accordance with manufacturer's instructions.
      b. This repair method is only used where approved by Engineer.

c. Groove and sealant shall be applied on wet or hydrostatic pressure side of surface.

C. Repair Method Use:

1. Repair Method 1: For cracks in walls, surfaces sloped 1:1 or greater, beams, columns, structural slabs, overhead surfaces, and liquid retaining surfaces. Need for repair depends upon crack width, location, and leakage.
2. Epoxy grout is used for repair of structural cracks and chemical grout (expanding urethane) for repair of non-structural cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural or non-structural.
3. Repair Method 2: Utilized in lieu of Method 1 for slabs when approved by Owner's Representative. Final finish shall match adjacent surfaces.
4. Repair Method 3: Limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as approved by Engineer. Repair Method 3 is not an equivalent repair method to Repair Methods 1 or 2, which shall be considered the standards.

3.16 CLEANUP

A. Upon completion of the work and prior to final inspection, clean all concrete surfaces as follows: Sweep with a broom to remove loose dirt, then mop and/or flush with clean water. Scrub by hand or machine as required to remove and blend stains or discolored areas .

B. Clean floors that have curing and sealing compound as stated above, followed by the final application of curing and sealing compound.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Adhesive anchor bolt grouting is specified in Section 05 05 20.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 05 05 20 Anchor Bolts

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
ASTM C230	Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C939	Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts

Reference	Title
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Non-shrink Grout
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Complete product literature, including mixing, handling and placement instructions for the following: Cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement.
   6. Current ICC Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with Section 01 45 29.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
      a. The Special Inspector shall furnish a report to the Engineer, Owner's Representative and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used

conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Quality Control by Contractor
   1. Provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 if a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
      a. The Special Inspector shall furnish a report to the Engineer, Owner's Representative and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

C. Certifications
   1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.

D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications.
   1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
   2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

E. Manufacturer Qualifications
   1. Manufacturer shall have a minimum of five years' experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
   2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

PART 2 PRODUCTS

2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved ready to use mixture requiring only water for use at the job site. Grout shall be NSF 61 compliant. The 2-inch cubes shall have a minimum compressive strength of 3,000 psi at 7 days and 7,000 psi at 28 days.

B. Cementitious non-shrink non-metallic aggregate grout shall be:
   1. BASF, Masterflow 928
   2. Euclid Chemical Company, Hi-Flow Grout
   3. Five Star Products, Inc., Five Star Grout
   4. Sika Corporation, SikaGrout 212
   5. Approved Equal

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45 degrees Fahrenheit and 90 degrees Fahrenheit and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout shall be a pourable, non-shrink, NSF 61 compliant, 100-percent solids system.

B. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be:
   1. BASF, Masterflow 648
   2. Euclid Chemical Company, E3-G
   3. Sika Corporation, Sikadur 42
   4. Approved Equal.

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
   2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
   3. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
   4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
   5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.

2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:
   1. Hilti, HIT-RE 500v3
   2. Simpson Strong Tie, SET XP
   3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or IAPMO Report. Adhesive shall be:
   1. Hilti, HIT-HY 70
   2. Simpson Strong Tie, SET XP
   3. Approved Equal acceptable per ICC Report or IAPMO Report for resisting earthquake loads

2.04 CONCRETE REPAIR MORTAR

A. Mortar shall be NSF 61 Compliant

B. Horizontal Applications: Repair mortars shall be:
   1. BASF
   2. Sika Corporation, SikaTop 111 Plus or SikaTop 122
   3. Approved Equal

C. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF
   2. Sika Corporation, SikaTop 123 Plus
   3. Approved Equal

2.05 CEMENT GROUT – NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term “non-shrink grout” is indicated on the Drawings. Use of this grout to support the bearing surfaces of machinery shall be a as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750

pounds. Grout shall be placed and cured in accordance with the manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.03 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of the Contract Documents, details on the Drawings, and in conformance with manufacturer's recommendations.

3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer's instructions.

3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the work.

3.06 CEMENT GROUT – NOT USED

END OF SECTION

SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete. Included are cast-in-place and post-installed anchors (adhesive systems and wedge type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

1.01 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 03 60 00 Grouting

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
IBC	International Building Code with local amendments

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.

2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Anchor bolt placement plans.
5. Anchor bolt, nut, and washer material information, including material certifications.
6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Utah. Calculations shall comply with the provisions of ACI 318-14, Chapter 17. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 psi unless otherwise noted.
7. Submit record copy of proof loading test results within five days after test.
8. Product Data:
    a. ICC Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
    b. Product data indicating load capacity charts/calculations.
    c. Chemical resistance.
    d. Temperature limitations.
    e. Manufacturers written installation instructions.
9. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program.

1.04 QUALITY ASSURANCE

A. Quality Assurance By Owner
    1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Owner and in accordance with IBC Chapter 17.
    2. A five percent sample of installed post-installed anchors shall be proof-loaded by an independent laboratory contracted by the Contractor. The quantity of samples and locations shall be coordinated with the Owner's Representative.
    3. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
    4. The Special Inspector shall furnish a report to the Engineer, Owner's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the

approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Sections 43 05 13 and 43 05 18, respectively.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts	ASTM A194 Heavy Hex Nuts, Type 316 ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316
Stainless Steel Washers	Type 316 to match bolt material
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36, Hot Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized
Concrete Adhesive Anchors	Hilti "HIT-RE 500v3", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Masonry Adhesive Anchors	Hilti "HIT-HY 70", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods

Material	Specification
Concrete Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or approved equal, Type 316 Stainless Steel
Concrete Expansion (wedge) Anchors*	Hilti “KWIK BOLT TZ”, or approved equal, Type 316 Stainless Steel

**Post installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Suitable for potable water supply (NSF-61 Certified).
   2. Formulated to resist washout.
   3. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on design drawings and as required by equipment manufacturer’s design.
   1. Provide high density polyethylene plastic sleeves of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:
   1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
      a. Acid concentrations higher than 10 percent
      b. Chlorine gas
      c. Machine or diesel oils
   2. Limit to applications where exposure to the following is extremely unlikely:
      a. Fire
      b. Concrete or rod temperature above 120 degrees F
   3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an Installer specially certified for overhead applications.
   4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
   5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
   6. Embedment depth shall be as specified or as required by the equipment manufacturer.
   7. Follow the anchor system manufacturer's installation instructions.
   8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core drilled holes are not allowed.
   9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
   10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25 degrees F.
   11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

B. Where slanting the drill does not resolve the conflict, notify the Owner's Representative and resolve the conflict to the satisfaction of the Owner's Representative in consultation with the Engineer.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.

E. Reinforcing steel in masonry shall not be damaged.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the state of Utah.
   2. Calculations and details for redesign shall be submitted.

END OF SECTION

SECTION 05 10 00

STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural metals consisting of standard shapes, hollow sections, fasteners, rods and plates that are used in structural supports and connections.

1.02 RELATED SECTIONS REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AISC 201	AISC Certification Program for Structural Steel Fabricators
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 341	Seismic Provisions for Structural Steel Buildings
AISC 360	Specification for Structural Steel Buildings
AISC 810	Erection Bracing of Low-Rise Structural Steel Frames
ASTM A6	General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Carbon Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A992	Structural Steel Shapes
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM F436	Hardened Steel Washers
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS-B3.0	Welding Procedures and Performance Qualifications

Reference	Title
AWS-D1.1	Structural Welding Code–Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
ASW D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction

1.03 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Shop drawings for approval prior to fabrication. Shop drawings shall not be reproductions of the Drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, coatings, connection details, blocks, copes, and cuts. Substitutions of details shown on the Drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the Drawings.
5. Certification that steel fabricator is approved to perform steel fabrication without special inspection.
6. AISC quality certification: Evidence that steel fabricator has AISC 201 Certification as a “Standard Steel Building Structures” fabricator. Certificate to show name and address of certified firm, effective date, and category of certification.
7. Welding procedures, qualifications, and inspection report.
8. Certified mill test reports for structural steel and high-strength bolts and nuts.
9. In accordance with IBC Chapter 17, Fabricator at the completion of fabrication to submit Certification of Compliance stating that the fabrication was performed in accordance with the design documents.
10. Certified copies of all surveys conducted by a registered professional engineer or surveyor showing elevations and locations of base plates and anchor bolts to receive structural steel or aluminum, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.04 QUALITY ASSURANCE

A. Quality Control by Owner:

1. Special Inspection of structural metals work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection of structural metals is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
2. All structural steel work shall receive Special Inspection in accordance with IBC, Chapter 17. Structural steel includes all steel elements that resist code-defined loads and whose failure would affect life safety. Items to be inspected include, but are not limited to, mechanical/electrical supports, beams, stringers, columns, access walkways and stairways.

B. Fabricator Qualifications:
1. A qualified fabricator must participate in the AISC 201 Certification program and be designated an AISC Certified Plant, Category STD (Standard for Steel Building Structures).

PART 2 PRODCUTS

2.01 MATERIALS

A. Steel:
1. Materials for structural metals shall be as specified in Table A.

Table A - Steel Materials

Material	Specification
Standard steel S-shapes, channels, angles and plates	ASTM A36
Standard rolled steel wide-flange sections and WTs	ASTM A992
Pipe sections for posts	ASTM A53, Type E or S, Grade B
Round Hollow Structural Sections (HSS)	ASTM A500, Grade B (Fy=42 ksi)
Square and Rectangular Hollow Structural Sections (HSS)	ASTM A500, Grade B (Fy = 46 ksi)
Stainless steel bolts (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F593, Type 316
Stainless steel nuts and washers (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F594, Type 316
Steel bolts (used at galvanized and painted steel framing)	Galvanized ASTM A325 (Type 1), bearing type bolts fully tensioned
Carbon steel nuts and washers	Galvanized ASTM A563 nuts and galvanized ASTM F436 washers

B. Aluminum:

Table B - Aluminum Materials

Material	Specification
Aluminum structural shapes	Alloy 6061-T6 per ASTM B308
Bolts	Use stainless steel bolts for aluminum framing (see Table A above)

Table B - Aluminum Materials

Material	Specification
Aluminum guardrail and handrail pipe	Alloy 6061-T6 or 6063-T6 per ASTM B241
Aluminum plates	Alloy 6061-T6 per ASTM B209

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept conditions before beginning work.

3.02 FABRICATION

A. Fabrication of steel shall be in accordance with the applicable provisions of the AISC Steel Construction Manual, Fifteenth edition. Fabrication of aluminum shall be in accordance with Aluminum Design Manual – Latest Edition. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under AISC 201 for Category STD (Standard for Steel Building Structures).

B. Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro-inch and ends shall be square within the tolerances for milled ends specified in ASTM A6.

C. Shop splices of members will be permitted only where indicated on the Drawings. Splices not indicated require the approval of the Owner's Representative.

D. Verify measurements at the job site prior to fabrication. Fabricate to match job site measurements.

E. Provide holes as necessary or as indicated for securing other work to structural steel framing, and for passage of other work through steel framing members.

3.03 INSTALLATION

A. General:
   1. Erection of structural steel shall be in accordance with the applicable provisions of AISC Steel Construction Manual. Erection plan shall conform to AISC 303. For low-rise structural steel buildings, 60 feet tall or less and a maximum of 2 stories, the structure shall be erected in accordance with AISC 810.
   2. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in place work.
   3. Employ a registered professional engineer or surveyor for accurate erection of the structural steel. Check elevations of concrete and locations of anchor bolts before erection proceeds and report discrepancies to the Owner's Representative.
   4. Placement tolerances shall be in accordance with AISC 303.
   5. After final positioning of steel members, provide full bearing under base plates and bearing plates using non-shrink grout. Place non-shrink grout in accordance with the manufacturer's instructions.
   6. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings

or isolators. Protect aluminum in contact with concrete or grout with a heavy coat of bituminous paint.

7. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned.
8. Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete.
9. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced.

B. Welding:

1. Welding shall be done by welders, welding operators, and tackers who have been qualified by tests as prescribed by AWS to perform the type of work required. The quality of welding shall conform to AWS Codes.
2. Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures.
3. Provide continuous seal welds for plates or structural shapes that are exposed to or submerged in water or wastewater.

C. Bolted Connections:

1. Bolted connections, unless noted otherwise, shall conform to AISC 360 and AISC 341, and shall be bearing type connections with bolts fully tensioned unless connecting HSS shapes. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation. No drifting of bolts or enlargement of holes will be allowed to correct misalignment. Holes shall not be cut or enlarged by burning. Mismatched holes shall be corrected with new material.

3.04 CORROSION PROTECTION

1. Unless otherwise specified, carbon steel shall be galvanized. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.
2. Grind all sharp edges off of the sheared plates and punched holes.
3. Grind uneven or rough welds with high beads to a smooth finish.

3.05 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be provided under work of other specification sections.
   2. Ladders, ladder cages, and safety posts
   3. Miscellaneous metal fabrications not covered elsewhere

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 05 20 Anchor Bolts
   3. Section 05 10 00 Structural Metal Framing
   4. Section 05 52 10 Aluminum Railings
   5. Section 05 53 10 Metal Gratings and Stair Treads

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction
ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements
ASTM A36	Carbon Structural Steel
ASTM A48	Gray-Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

Reference	Title
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A240	Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Stainless Steel Bars and Shapes
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength
ASTM A312	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A489	Carbon Steel Lifting Eyes
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A554	Welded Stainless Steel Mechanical Tubing
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
ASTM A780	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
ASTM A786	Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Rolled Floor Plate, Stainless Steel
ASTM A924	Steel Sheet, Metallic-Coated by Hot-Dip Process
ASTM A992	Structural Steel Shapes
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211	Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Hardened Steel Washers
ASTM F468	Nonferrous Bolts, Hex Cap Screws, SocketHead Cap Screws and Studs for General Use
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum

Reference	Title
AWS D1.6	Structural Welding Code - Stainless Steel
OSHA 29 CFR 1910.27	Fixed Ladders
OSHA 29 CFR 1926.502	Fall Protection Systems Criteria and Practices
SSPC SP5	White Metal Blast Cleaning
IBC	International Building Code

1.04 DEFINITIONS

A. Galvanize: Hot-dip galvanize per ASTM A123 or ASTM A153, per Section 05 05 14.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration
   4. Manufacturer's product data.
   5. Detailed Shop Drawings:
      a. Fabrication drawings showing layouts, connections to structural system, and anchoring details.
      b. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions.
      c. Construction details, reinforcement, anchorage, and installation with relation to the building construction.
   6. Welding procedures and welder certificates and qualifications.
   7. Passivation method for stainless steel fabrications.

1.06 QUALITY ASSURANCE

A. Qualifications
   1. Fabricator shall have a minimum of five years experience in fabrication of metal specified.

B. Certificates

1. Certified welding procedures and welding operators in accordance with AWS. Welding operator certificates shall be no more than one-year old and the welder shall have used the welding process to be performed within the last six months.

C. The use of salvaged, reprocessed or scrap materials will not be permitted.

D. Shop Assembly: Items in the shop shall be preassembled to the greatest extent possible, so as to minimize field splicing and assembly of units. Units shall be disassembled only to the extent necessary for shipping and handling limitations. Units shall be clearly marked for reassembly and coordinated installation.

1.07 DELIVERY, STORAGE AND HANDLING

A. Avoid damage during delivery and handling of fabrications.

B. Store off the ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for miscellaneous metalwork are specified in the following table.

Material	Specification
Steel	
Sheets, plates and shapes (except W shapes)	ASTM A36
W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade B
Headed Anchor Studs	ASTM A108
Carbon steel bolts	ASTM A307, Grade A
High strength bolts	ASTM A325 (Type 1)
Nuts	ASTM A563
Washers	ASTM F436
Stainless Steel	
Sheet and Plates	ASTM A240, Type 316 or 316L
Shapes, bars, and similar items	ASTM A276, Type 316 or 316L
Pipe	ASTM A312, Type 316 or 316L
Headed Anchor Studs	ASTM A276, Type 316L
Bolts	ASTM F593, Type 316
Nuts	ASTM F594, Type 316
Aluminum	
Sheets and plates	ASTM B209, Type 6061-T6

Material	Specification
Bars, flats and similar items	ASTM B211 or B221, Type 6061-T6
Shapes	ASTM B308, Type 6061-T6
Round tubing and pipe	ASTM B241, Type 6061-T6
Square and rectangular tubing	ASTM B221, Type 6063-T52
Pipe	ASTM B211 or B241, Type 6061-T6
Bolts, Stainless Steel	ASTM F593, Type 316
Nuts, Stainless Steel	ASTM F594, Type 316
Checker Plate	
Steel	ASTM A786
Stainless steel	ASTM A793, Type 304
Aluminum	ASTM B632, Type 6061-T6
Other steel items	
Iron castings	ASTM A48
Eyebolts	ASTM A489
Threaded rods	ASTM A36

2.02 FABRICATION

A. General

1. Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.
2. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.
4. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.
5. Fabrication, including cutting, drilling, punching, threading and tapping required for fabrications or adjacent work, shall be performed prior to galvanizing.

B. Ladders

1. Steel Ladders: Provide vertical ladders conforming to 29 CFR 1910.27. As a minimum, provide 2 1/2 inch by 3/8 inch steel flat bars for side rails and 3/4 inch diameter steel rods for rungs unless otherwise indicated on the Drawings. Rungs shall be a minimum clear length of 16 inches, uniformly spaced at a maximum of 12 inches and plug welded into side rails. Install ladders so that the distance from the centerline of rungs to the finished wall surface is not less than 7 inches nor more than 12 inches. Provide clip angle supports bolted to the side rail at the top. Provide intermediate clip angle lateral supports at a maximum of 10 feet on center.
2. Ladder Rail Fall Protection System:

a. System shall consist of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to harness belt can be attached.

b. Rail:

1) Notched at six-inch intervals and constructed of stainless steel Type 316.

2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.

3) For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.

4) Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescopic safety post.

5) Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder. Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness.

c. Accessories: Provide with each ladder the following, all furnished by the fall prevention system Supplier:

1) One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.

2) One safety harness that attaches to sleeve. Harness shall be of woven high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.

3) One shock adsorbing lanyard no longer than six-feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double locking hooks at each end.

d. Acceptable ladder rail fall protection systems include:

1) Miller Saf-T-Climb as manufactured by Honeywell

2) Vertical Rigid Track Fall Arrest System as manufactured by Diversified Fall Protection

3) Approved equal

C. Other Miscellaneous Steel Metalwork

1. Other miscellaneous steel metalwork including embedded and non-embedded steel metalwork, hangers and inserts shall be as specified or shown on the Drawings, and shall be galvanized after fabrication unless otherwise noted.

2.03 FINISHES

A. Shop Painting [NOT USED]

B. Aluminum Surfaces

1. Surface condition aluminum before finishes are applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.
3. Provide other aluminum items with a standard mill finish.
4. Provide a coating thickness not less than that specified for protection.
5. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations.
6. Provide a polished satin finish on items to be anodized.

C. Stainless Steel Passivation
1. Stainless steel to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380. Passivate to remove iron compounds from the surface of the stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

3.02 PREPARATION

A. Make provisions for erection loads with temporary bracing. Keep work in alignment.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.03 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.

E. Fastening to Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.

F. Set steel stair baseplates on wedges, or shims. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

G. Railing: Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing required by design loads and as limited on Drawings. Plumb posts in each direction.

3.04 REPAIR/RESTORATION

A. Galvanized
   1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.
   2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.
   3. Use zinc-rich repair paint. Acceptable manufacturers:
      a. LPS, Cold Galvanize
      b. ZRC Worldwide, ZRC Galvilite
      c. Approved Equal

B. Painted
   1. After installation, clean and touch up damaged areas with the same materials used for the shop coat.

3.05 FIELD QUALITY CONTROL

A. Electrolytic Protection

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Stainless Steel
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
   3. Remove contamination in accordance with requirements of ASTM A380.
   4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

END OF SECTION

SECTION 05 52 10

ALUMINUM RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Prefabricated anodized aluminum component type guardrail and handrail systems; herein referred to as railing.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B483	Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.2	Structural Welding Code, Aluminum
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will

signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. Layout, installation, and detail shop drawings for railing.
5. Design calculations stamped and signed by a licensed professional engineer in the State of Utah. Railing and base support connections to be designed by the Contractor incorporating specified criteria and provisions in the current building code with local governing amendments.

B. Informational Submittals:
   1. Material certification for compliance with this specification for aluminum and stainless steel materials.

1.05 QUALITY ASSURANCE

A. General:
   1. Railing shall conform to the standards of the Occupational Safety and Health Administration (OSHA) and International Building Code.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation.

B. Leave wrap intact, insofar as possible, until railing is completely installed.

PART 2 PRODUCTS

2.01 PERFORMANCE/DESIGN CRITERIA

A. Railing assembly and attachments shall resist a minimum uniform load of 50 pounds per linear foot on the top rail and a concentrated load of 200 pounds (not acting concurrently with the uniform load) applied in any direction. Contractor's supplier and engineer are responsible for designing the guardrail/handrail system along with its base support and anchor bolt size and embedment depth into concrete, or connection to metal framing, to resist the above loading condition taking into account anchor edge distances and concrete strengths at the point of attachment. Contractor shall submit calculations signed and sealed by a professional engineer in the State of Utah.

B. Thermal Movements: Provide railing that allow for thermal movements resulting from the project site maximum range in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

2.02 MANUFACTURERS

A. Julius Blum & Co., Inc.

B. Golden Railing Inc.

C. Moultrie Manufacturing.

D. American Railing Systems, Inc.

E. Approved equal.

2.03 MATERIALS

Component	Material
Aluminum pipe	ASTM B210 Alloy 65060-T832; ASTM B 221 Alloy 6063-T5/T52; ASTM B 429, Alloy 6063-T832; ASTM B483, Alloy T832
Aluminum plate	ASTM B209, Alloy 6061-T6
Stainless steel bolts	ASTM A593, Type 316
Stainless steel nuts and washers	ASTM A594, Type316

2.04 CONFIGURATION/COMPONENTS

A. Guard Top Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

B. Intermediate Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

C. Handrails: 1 1/2 inch nominal diameter pipe, Schedule 40.

D. Posts: Minimum 1 1/2 inch nominal diameter pipe, Schedule 80.

E. Provide manufacturer’s heavy-duty base fitting with stainless steel set screws.

F. Provide aluminum toe boards at guardrails, except where concrete curbs are indicated. Aluminum toe boards shall be minimum 3/16-inch thick plate, connected to the posts.

G. Bolts, including anchor bolts, shall be Type 316 stainless steel.

H. Fittings:
   1. Fittings shall be cast aluminum elbows, T-shapes, post brackets and escutcheons. Provide adapter and anchor plugs as required for a complete installation.
   2. Floor sleeves for removable railing shall be stainless steel, embedded in concrete.

2.05 ASSEMBLY/FABRICATION

A. Pipe cuts shall be clean, straight, square and accurate for minimum joint gap. Work shall be done in conformance with the guardrail and handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits of any type which can affect durability, strength, or appearance.

B. Guardrailing and handrailing shall be connected by screws or bolts or welding. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Wherever needed because of the thickness of the metal, holes shall be subpunched and reamed or drilled. Components with mismatched holes shall be replaced. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.

C. Supply components required for anchorage of fabrications.

D. Where shop welding is used, grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints tight and flush. Round exposed edges to small, uniform radius. Use filler alloy rods that will not discolor when anodized, such as ER 5154, ER 5254, ER 5183, ER 5356 or ER 5556 filler alloy rods.

2.06 ISOLATION COATING

A. Isolation coating shall be applied to all aluminum surfaces in contact with concrete, masonry, or dissimilar metals. Use a heavy coat of bituminous paint.

2.07 FINISHES

A. Clear anodized in accordance with the Aluminum Association AA-M12-C22-A41. Anodize exposed prefabricated components, except stainless steel fasteners, after fabrication.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field verify measurements for railings before fabrication.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Accurately place metal to be embedded in concrete and hold in correct position while the concrete is placed. Where recesses or blockouts are formed in the concrete, grout metalwork in place after concrete has attained its design strength in accordance with Section 03 30 00.

D. Unless otherwise indicated, field welding of railing is not permitted.

3.03 TOLERANCES

A. Maximum variance from plumb: 1/4 inch.

B. Maximum offset from true alignment: 1/4 inch.

END OF SECTION

SECTION 05 53 10

METAL GRATINGS AND STAIR TREADS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: stainless steel bar grating and stair treads.

1.02 RELATED SECTIONS

A. This section contains references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A380	Cleaning, Descaling, and Passivation of Stainless Steel
ASTM A666	Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, and High-Strength Low-Alloy
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ANSI/NAAMM	Metal Bar Grating Design Manual

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   1. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Shop drawings showing placing plans for grating.
    a. Provide layout and fabrication details of support frames.
    b. Provide panel layout with individual panel dimensions.
4. Manufacturer's product data with load tables.

PART 2 PRODUCTS

2.01 MATERIALS

Component	Material
Stainless steel grating	ASTM A167 or A666, alloy 316L

2.02 ASSEMBLY/FABRICATION

A. Welds:
1. Grind smooth rough welds and sharp metal edges. Make welds exposed to view uniform and neat.

B. Clearance: provide ¼" separation between panels and at bearing ends of panel to support frame.

C. Grating:
1. General
    a. Provide serrated grating for slip resistance.
    b. Bearing bars and cross bars are continuous.
    c. Openings shall be banded with bars having the same dimensions as the bearing bars. Band perimeter edges with bars flush at the top surface of the grating and 1/4 inch clear of the bottom surface.
    d. Bars terminating against edge bars shall be welded to the edge bars when welded construction is used.
    e. When crimped or swaged construction is used, bars at edges shall protrude a maximum of 1/16 inch and be peened or ground to a smooth surface.
    f. Fabrication methods employing bending or notching of bearing or cross bars is not permitted.
    g. Maximum grating panel weigh shall not exceed 80 pounds.
2. Stainless Steel Grating
    a. Use only where specified. Stainless steel grating to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380.

D. Stair Treads:
1. Treads shall match the grating material and type furnished for landings. Use serrated surface for slip resistance. Provide abrasive nosings on each tread. Provide carrier angle at each end for attachment to stair stringers. Attach components to support members with Type 316 stainless steel fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field measure grating for proper cutouts and sizes prior to fabrication.

3.02 INSTALLATION

A. Fieldwork is not permitted on galvanized items.

B. Drilling of bolts or enlargement of holes to correct misalignment is not permitted.

C. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Protect aluminum in contact with concrete with a heavy coat of bituminous paint.

D. Use stainless steel metalwork to be embedded in concrete. Clean surfaces in contact with or embedded in concrete and hold in correct position while concrete is placed. Or, provide formed recesses or blockouts in concrete and then, after concrete has attained design strength, grout metalwork in-place using non-shrink grout.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 00.01

COMMON WORK RESULT FOR ELECTRICAL FOR SMALL PROJECTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope: This section specifies general requirements for electrical work. Project Detailed requirements specified in other sections are subject to the general requirements of this section.

1. Furnish labor, equipment, tools, materials, supplies, and perform operations necessary to install a complete and operable electrical system. Furnish incidental material and perform work shown on the Drawings and in the Specifications.
2. Perform electrical work and provide material and equipment in compliance with applicable National, State, and Local codes, regulations, laws, and ordinances.
3. Obtain electrical permits, arrange for required inspections, correct deficiencies resulting from inspections, and pay permit fees and inspections charges. Pay fines and the cost of extra work incurred by action or inaction of the Contractor, at no additional cost to the Owner.
4. Furnish properly executed certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) at the conclusion of the work, before final acceptance.
5. Adhere to the Area Classification shown for the product required and the installation required. Provide products in Hazardous Classified Areas in accordance with NEC Article 500 for the Class and Division specified or identified and products in corrosion areas in accordance with this specification.
6. Maintain a complete set of Contract Drawings in “Record” condition, available for review by the Owner or Engineer. Mark, initial, and date changes, modifications, or corrections, as they occur. Refer to the Record Drawing specification section requirements.
7. Field verify the exact locations of equipment or equipment terminations. Use accepted equipment submittals as the basis of the conduit openings and slab penetrations.

B. Power and Telephone Utility Coordination:

1. Coordinate the service entrance / metering equipment, and the utility service with the project electrical power utility during the submittal process and installation.
2. Obtain electrical power utility installation requirement for power service for the project; obtain the power utility standards and installation details that apply to the project; apply for electrical service; request power utility inspection; and complete electrical equipment acceptance testing.
3. Provide Electric Utility standard service entrance power equipment and utility billing meter equipment. Obtain power utility approval for the equipment prior to shipment.
4. Coordinate primary and secondary electric service entrance underground or overhead installation with the electric power utility.
5. Coordinate telephone underground or overhead service installation with the telephone utility.

C. Drawing Definitions and Requirements:

1. Elementary or Schematic Diagram: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement that facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
2. One-Line Diagram: Shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.
3. Block Diagram: Diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
4. Wiring Diagram or Connection System: Includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. A panel layout diagram shows the physical location of devices and the wiring connections.
5. Interconnection Diagram:
    a. Shows external connections between terminals of equipment in panels or electrical assemblies and outside points, such as motors, auxiliary devices, control devices, and instruments. Provide references to connection diagrams that interface to the interconnection diagrams of the continuous line type.
    b. Show bundled wires as a single line with the direction of entry/exit of the individual wires clearly shown. Show each wire identification as actually installed. Wireless diagrams and wire lists are not acceptable.
    c. Provide wire identification for each end of the same wire for devices and equipment, indicate terminal blocks identification actually installed with individual terminal identification.
    d. Show jumpers, shielding and grounding termination details not shown on the equipment connection diagrams on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Show spare wires and cables.
6. Arrangement, Layout, or Outline Drawings: Shows the physical space and mounting requirements of a piece of equipment and may indicate ventilation requirements, space provided for connections, or the location connections are to be made.
7. Drawing Cross-Referencing:
    a. Reference each submittal drawing submitted to the associated Contract Document and indicate the one-line diagrams, schematics, control diagrams, block diagrams, and Process and Instrumentation Diagrams (P&IDs) cross-referenced on the submittal drawings.
    b. Internally cross-reference submittal drawings related to the same subject shall be referenced to other submittal drawings. Failure to cross-reference Contract Documents with the submittal shall be cause for rejection of the entire submittal with no further consideration.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains

references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1 / ASCE 7	Minimum Design Load in Buildings and Other Structures, 1982
ANSI C80.1	Rigid Steel Conduit - Zinc Coated, 1994
ASTM B3	Standard Specification for Soft or Annealed Copper Wire, 2001
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft, 1999
ASTM B33	Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes, 2000
ICEA S-68-516 / NEMA WC 70, 71, & 74	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-95-658	Standard for Non-Shielded Power Cables Rated 2000 Volts or Less, 2000
IEEE 81	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, 1983
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations, 1974 (1992)
JIC EMP-1	Electrical Standard for Mass Production Engineering, 1967
NEMA TC2	Electrical Polyvinyl Chloride (PVC) Conduit, 2003
NEMA 250	Enclosures for Electrical Equipment (1000 Volt Maximum)
NEMA WC-70	Non-Shielded Power Cable 2000V or Less (ICEA S-95-658), 1999 (2001)
NEMA WD-1	General Requirements for Wiring Devices, 1999
NFPA 70	National Electrical Code (NEC)
UBC	Uniform Building Code
UL 6	Electrical Rigid Metal Conduit – Steel, 12th Edition, 2000 (2003)
UL 44	Thermoset-Insulated Wires and Cables, 15th Edition, 1999 (2002)
UL 67	Panelboards, 11th Edition, 1993 (2003)
UL 83	Thermoplastic-Insulated Wires and Cables, 13th Edition, 2003 (2004)
UL 263	Fire Tests of Building Construction and Materials, 13th Edition, 2003
UL 360	Liquid-Tight Flexible Steel Conduit, 5th Edition, 2003
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, 10th Edition, 2002 (2003), Adopted: NEMA AB 1-1999
UL 1277	Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, 4th Edition, 2001 (2003)

B. Listed and Labeled Products:
   1. Provide electrical equipment and materials listed or labeled by an independent testing laboratory for the purpose for which they are to be used and provide associated testing laboratory label.
   2. The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction. Test Laboratory examples: Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), and Canadian Standards Association (CSA).
   3. Include costs and expenses incurred for special inspections in the contract price for electrical products required to undergo a special inspection either at the manufacturer's place of assembly or at the installed location by the local inspection authority when a product is not available with a testing laboratory listing or labeling.

C. Factory Tests:
   1. Perform factory tests at the place of fabrication and on completion of manufacture or assembly where specified in the individual product specification section.
      a. Include the costs of factory tests in the contract price.
      b. Include the costs of Engineer witness of factory tests in the contract price.

1.03 SUBMITTALS

A. The following information shall be provided for all electrical equipment and materials in accordance with Section 01 33 00:
   1. Catalog cuts of equipment, devices, and materials requested by the individual specification sections.
      a. Catalog information with technical specifications and application information including ratings, range, weight, accuracy, and other pertinent product information.
      b. Edit catalog cuts to show only the items, model numbers, and information that apply.
      c. Assemble catalog cuts in a folder or three ring binders with a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
   2. Arrangement, layout, and outline drawings with dimensions and weight, as appropriate.
   3. Control schematics and interconnection wiring diagrams depicting internal and external wire and cable terminations. Drawing cross-reference to specification and Contract Document drawings.

1.04 DRAWINGS

A. Prepare specified drawings on 11-inch by 17-inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

B. Prepare drawings to reflect the final constructed state of the project installation or supplied equipment. Provide drawing quality, clarity, and size of presentation to permit insertion in operation and maintenance manuals.

1.05 PROJECT/SITE CONDITIONS

A. General:
   1. Unless otherwise specified, equipment and materials shall be sized and de-rated for the ambient conditions, but not less than an ambient temperature of 40 degrees C at an elevation ranging from sea level to 4733 feet without exceeding the manufacturer's stated tolerances.

B. The following areas are designated as corrosive:
   1. None

C. Hazardous (Classified) Areas:
   1. None

D. Seismic:
   1. Electrical equipment and supports shall be braced in accordance with all applicable building codes.

E. Construction Materials:
   1. Refer to the individual specification section for each component for material composition and installation practices.
   2. Construction materials required for each area classification are listed in the following table that specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit shall be galvanized rigid steel conduit: RACESPEC type RGS-Steel.

Location	Application/Condition	RACESPEC
Indoor non-corrosive	Exposed	RGS-Steel
Indoor corrosive	Exposed	PVC coated RGS-Steel
Outdoor	Exposed	RGS-Steel
Hazardous	Exposed	RGS-Steel
Concealed	Embedded in concrete structure or beneath slab-on-grade	RGS-Steel, RNC40, or RNC80, as shown
Underground	Instrumentation, communications and data signals encased in concrete, ductbank	RGGS-Steel, RNC40, or RNC80, as shown
Underground	Instrumentation, communications and data signals directly buried	RGS-Steel, RNC40, or RNC80, as shown
Underground	Power directly buried (Non-Power Utility)	RNC40
Nonhazardous	Final connection to equipment	RGS-Steel
Hazardous	Final connection to equipment	Fittings per NEC Article-500 for the Classified Hazardous Area identified.
Corrosive	Final connection to equipment	PVC coated RGS-Steel, NC40, RNC80, Flexible Steel Fittings, as appropriate

Notes:

1. *Install conduit connections to control stations, enclosures, and device boxes through threaded hubs.*
2. *Install flexible conduit for final connections to devices, equipment and motors not exceeding 18 inches. Limit length to 36 inches where flexibility is required.*

3. *Mount enclosures, device boxes, control stations, and raceway systems with 1/4-inch (minimum) air space between the electrical system and supporting structure.*

1.06 STORAGE OF MATERIALS AND EQUIPMENT

A. Store equipment and materials in the factory-sealed container and protect with additional covering and materials to avoid physical damage or weather damage.

1.07 ELECTRICAL NUMBERING SYSTEMS

A. Raceway Numbers:
   1. Tag raceways with brass tags at the access locations including manholes, pull boxes, junction boxes, and at the terminations.
   2. Tag raceways with aluminum tags where subject to hydrogen sulfide atmosphere typically found at wastewater treatment facilities.
   3. Raceway numbers are derived from the “Cable and Conduit Schedule” or the ductbank cross-sections. Where raceway numbers are not provided, use the circuit number on the power and control single line diagrams.

B. Wire and Cable Circuit Numbers:
   1. Identify wire and cable circuit numbers at both ends. Refer to the circuit labeling method specified and shown in the drawings to label circuits.
   2. Identify lighting and receptacle branch circuits with the power source and circuit load, at source and destination locations. Identify the load, location, and circuit in typed panel schedules with corrections shown.
   3. Include copies of schematic diagrams, wiring connection diagrams, and interconnection diagrams inside of the equipment enclosure, protected in a plastic container in the equipment print holder.

PART 2 – PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Provide new equipment and materials free from defects. Provide material and equipment of the same or a similar type of the same manufacturer throughout the work. Use standard production materials wherever possible.

B. Paint Finish and Galvanizing:
   1. Paint installed and unpainted electrical construction materials. Galvanize products, supports, etc. as specified in the Hot-Dip Zinc Coating section.

2.02 RACEWAYS, BOXES, AND SUPPORTS

A. Raceways and Boxes:
   1. Pullboxes, handholes, and device boxes are generally called boxes herein. Size boxes, manholes, and handholes in accordance with the National Electrical Code. Provide separate raceways for lighting, receptacles, power, control, instrumentation, and signaling systems.

B. Boxes and Wireways:
   1. Provide indoor boxes, larger than FD boxes, constructed of stainless steel.
   2. Provide boxes constructed of stainless steel rated NEMA-4X for corrosive areas and for outdoor locations.
   3. Size and provide wireways at locations above and below boxes, panels and groups of devices. Comply with the NEC sizing for conductor fill requirements. Wireway NEMA type shall match the location and area classification and equipment NEMA enclosure ratings.

C. Terminal Cabinets:
   1. Provide cabinets located indoors-conditioned space with NEMA-12 rating. Provide cabinets located outdoors, in process areas and in corrosive areas with NEMA-4X rating of stainless steel. Provide cabinets with hinged doors and 2 or 3-point stainless steel quick release latches with locking features via handle or latching clasps with provisions for padlocks.
   2. Provide adjustable terminal strip mounting accessories and with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Provide No. 8 minimum strap-screw type terminal strip, suitable for ring tongue, locking spade terminals. Provide Phoenix Contact products with capture feature and terminal identification method per terminal, as specified.

D. Manholes, Handholes and Pullboxes:
   1. Manholes, handholes and pullboxes generally called boxes herein, contain wires, cables, and conductors. Provide box dimensions where shown. Provide boxes per NEC sizing rules where the dimensions are not sized or shown.
   2. Provide concrete boxes with covers designed for H-20 loading in traffic areas. Engrave box cover: "ELECTRICAL". Provided boxes with hinged, aluminum checkered plate covers with pull-handle to open in non-traffic areas.
   3. Provide precast Quazite Compsolite cement/polymer products, or equal, for handholes, pullboxes, manholes, meter boxes, equipment pads, and vaults where allowed by the electric power utility and for projects where precast concrete is not specifically shown or specified.
   4. Electrical manholes and/or handholes shall be installed with gravity drain piping to daylight. No French drains or gravel bottoms will be acceptable.

E. Raceway and Box Supports:
   1. Provide stainless steel framing channel with end caps to support groups of conduit. Provide individual conduit supports that have one-hole stainless steel malleable iron pipe straps used with stainless steel clamp backs and nesting backs.
   2. Provide stainless steel supports, channel, fittings, all-thread, and fasteners in outdoor locations, in corrosive areas, and as shown. Provide factory end-caps for supports and channels.
   3. Independently support boxes by stainless steel brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden or plastic plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

F. Underground Marking Tape:
   1. Provide low-density, polyethylene plastic, underground marking tape and install above and centered for early warning protection for digging near electrical ductbanks.
   2. Provide Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal. Provide tape with nominal dimension of 6 inches wide, 4-mil thickness.
   3. Provide underground marking tape 6-inch wide metallic-lined tape with red polyethylene film on top and with clear polyethylene film on the bottom of the tape for installation above and centered on direct buried cables and conduits without ductbank encasement.
   4. Provide black over red marking tape clearly printed with: "CAUTION ELECTRIC LINE BURIED BELOW", or provide OSHA approved marking tape.

G. Nameplates:
   1. Provide nameplates for all boxes and enclosures with nameplate wording as shown on the drawings. Provide the tag number or box number with device functional description on device nameplate. Nameplate wording may be changed without additional cost where changes are made during the submittal process or prior to commencement of engraving.
   2. Provide machine engraved laminated white phenolic nameplates with black lettering for panel-mounted equipment with the instrument tag number/description in 3/32-inch minimum size lettering and attach to the panel or enclosure with a minimum of two self-tapping 316 stainless steel screws. Provide nameplates for power sources indicating the power loads and nameplates for power loads that indicate the power sources, in accordance with these specifications and the NEC.

H. Raceway Markers:
   1. Provide raceway markers: 0.036-inch minimum thickness, solid brass tags or aluminum tags with raceway number or the circuit number, stamped in 3/16-inch minimum height characters and attach tags to the raceway with 316 stainless steel wire. Install raceway markers inside of pull boxes, handholes, manholes, and where entering electrical equipment enclosures.
   2. Provide raceway markers indicating the power source and circuit number for lighting and receptacle raceways to the associated panelboard. Interior lighting and receptacle raceways do not require raceway markers for conduit between components.

I. Identification Tags:
   1. Provide the following:
      a. Equipment: Typical size 1-inch x 3-inch wide, white with black engraved equipment number and equipment description.
      b. Raceway/Conduit: Tags with raceway or conduit number or circuit shown.
      c. Instrument: 1.5-inch wide, aluminum tag with instrument number and description.
      d. Conductor: Power, control, or instrument cable with the circuit identified as shown; power source or power/control panel identified; power load, equipment, instrument, or device identified; purpose of the conductors identified.

e. Fastener: nylon-coated 48-mil stainless steel wire. Manufacturer: Brady catalog number 23310 or equal with double ferrule type brass wire clamps. Manufacturer: Brady number 23312.

J. General Raceway Requirements:
   1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
   2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes. The RACESPEC sheets with specified requirements begin on the next page.

2.03 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RGS-STEEL

A. Raceway Identification:
   1. RGS-Steel

B. Description:
   1. Rigid Galvanized Steel Conduit

C. Compliance:
   1. ANSI C80.1, UL 6

D. Finish:
   1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

E. Manufacturers:
   1. Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.

F. Minimum size:
   1. Unless otherwise shown: 3/4-inch for exposed; 1-inch for concealed or embedded; 2-inch for ductbank encased.

G. Fittings:
   1. Hubs:
      a. Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or equal.
   2. Unions:
      a. Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.

H. Boxes:
   1. Indoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA-4 watertight. Boxes in corrosion areas shall be NEMA-4X.

b. Conduit bodies: ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.

2. Outdoor:

a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-4X stainless steel nonmetallic for 6 inches square and larger.

I. Elbows:

1. (3/4" thru 2.5")

a. Factory fabricated or field bent.

2. (3" thru 6")

a. Factory fabricated.

J. Conduit Bodies:

1. (3/4" thru 4")

a. Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.

2. (5" and 6")

a. Electro-galvanized iron or cast iron box.

K. Expansion Fittings:

1. Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

L. Manufacturers:

1. Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.

M. Installation:

1. Rigid steel conduit shall be made up tight and without thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
2. Conduit entering boxes shall be terminated with a threaded hub as specified or standard fittings with grounding bushing.
3. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

2.04 RACEWAY SPECIFICATION SHEETS (RACESPEC) - LFSC

A. Raceway Identification:

1. LFSC

B. Description:

1. Liquid-Tight Flexible Steel Conduit

C. Application:

1. Final connection to equipment subject to vibration or adjustment.

D. Compliance:
   1. UL 360

E. Construction:
   1. Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquid-tight plastic cover.

F. Minimum size:
   1. 3/4 inch

G. Fittings:
   1. Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.

H. Installation:
   1. Do not exceed 36-inch length.

2.05 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RNC40 AND RNC80

A. Raceway Identification:
   1. RNC40 and RNC80

B. Description:
   1. Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage. DZYR per NEC Article 352.

C. Compliance:
   1. NEMA TC2, UL 651

D. Construction:
   1. Schedule 40, high-impact, polyvinyl-chloride (PVC)
   2. Schedule 80, high-impact, polyvinyl-chloride (PVC)

E. Minimum size:
   1. 3/4 inch exposed; 2-inch embedded or encased

F. Fittings:
   1. PVC solvent weld type

G. Boxes:
   1. Indoor:
      a. NEMA Class 4, nonmetallic
   2. Outdoor and corrosive:
      a. NEMA Class 4X, nonmetallic

H. Installation:
   1. PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard PVC couplings.
   2. PVC conduit shall have bell ends where terminated at manholes, handholes, or building walls. Bell ends shall terminate flush at the walls and floors and not extend or protrude.

2.06 RACEWAY SPECIFICATION SHEETS (RACESPEC) - PVC COATED RMC-STEEL

A. Raceway Identification:
   1. PVC Coated RMC-Steel

B. Description:
   1. Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated

C. Compliance:
   1. ANSI C80.1, UL 6

D. Finish:
   1. Hot-dip galvanized rigid steel conduit, to which a minimum 40-mil thick PVC coating has been bonded to the outside of the conduit. A 2-mil coat of urethane coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat. Elbows and fittings shall be factory made and coated.

E. Fittings: (includes unions, condulet bodies and expansion fittings)
   1. Refer to RACESPEC RMC-Steel for additional requirements. Similarly coated to the same thickness as the conduit and provided with type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company.
      a. Hubs:
         1) Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded with the same PVC coating as the conduit and provide a watertight connection.
      b. Boxes:
         1) Refer to RACESPEC RMC-Steel. FD boxes shall be PVC coated.
      c. Elbows:
         1) Refer to RACESPEC RMC-Steel.

F. Manufacturers:
   1. PVC coated conduit shall be by Robroy Industries, PLASTI-BOND RED; Occidental Coating Company (OCAL), or equal.

G. Installation:
   1. Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the conduit manufacturer.

2. Conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Painted fittings are not acceptable.
3. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material.

2.07 RACEWAY SPECIFICATION SHEETS (RACESPEC) - WW

A. Raceway Identification:
   1. WW

B. Description:
   1. Wireway and Auxiliary Gutter with hinged covers.
   2. Match the area classification enclosure type where installed.

C. Compliance:
   1. JIC EMP-1 and NEC Article 366

D. Minimum size:
   1. 4-inch x 4-inch
   2. Length as shown or determined by the installation requirements.

E. Maximum size:
   1. Sized in accordance with NEC-366 fill rules

F. Finish:
   1. Smooth finished surfaces.

G. Application:
   1. As shown on the drawings and where required.

H. Hardware, Supports, Fittings, and Fasteners:
   1. Stainless steel

I. Fasteners:
   1. Quick release 1/4 turn type or suitable for the area classification.

2.08 RACEWAY SPECIFICATION SHEETS (RACESPEC) – XPFS

A. Raceway Identification:
   1. XPFS

B. Description:
   1. Explosion-proof Flexible Steel Conduit

C. Application:

1. XPFS Conduit coupling shall be used for final connections to motors and other equipment subject to vibration or adjustment in Class I Division 1 hazardous areas and shall be watertight.

D. Size:
   1. 1/2 inch – 4-inch

E. Length:

F. 4-inch – 36-inch

2.09 RACEWAY SPECIFICATION SHEETS (RACESPEC) – TRAY

A. Raceway Identification:
   1. TRAY

B. Description:
   1. Cable Tray: ladder type with rungs and side rails.
   2. Cable Tray Covers: Where shown
   3. Bottom to side rail connections shall be positive mechanical joints to assure lateral and longitudinal stability.
   4. Aluminum:
      a. AA-6063-T6.

C. Application:
   1. Electrical Room or as shown on the drawings.

D. Compliance:
   1. NEMA VE-1

E. Loading and Deflection Requirements:
   1. The trays shall be designed and constructed to support a uniformly distributed load when tested as a single span, simple beam:

NEMA Load/Span Designation:

Class	Support Span Feet	Working Load (lbs/linear feet)
8A	8	50
8B	8	75
8C	8	100
12A	12	50
12B	12	75
12C	12	100
16A	16	50
16B	16	75
16C	16	100
20A	20	50
20B	20	75

20C	20	100

F. Dimensions:
   1. Width and depth shall be as specified or shown.

Width (inch)	Loading Depth (lbs/linear feet) 3”	4”	5”	6”
6	22	29	36	44
12	44	58	72	88
18	65	87	108	130
24	88	116	144	175
30	108	144	180	216
36	130	174	216	260

G. Finish:
   1. Aluminum.

H. Accessories:

I. Fittings, barriers and covers shall be of the same materials, finish and construction as the straight tray products.

2.10 CONDUCTORS, WIRE, AND CABLE

A. Provide products specified.

B. Unscheduled Conductor Sizing:
   1. Size conductors, wire, and cables in accordance with the National Electrical Code where not specified on the Drawings, and install in the minimum size raceway as specified in the RaceSpecs herein.

C. Control Wire Color Coding:
   1. Provide control wires with the following colors for the shown voltage:

120 Vac Power, line and load	Black
120 Vac Control	Red
24 Vac	Orange
12 Vac	Brown
Foreign Voltage (AC) (Interlock)	Yellow
AC Neutrals	White
Ground	Green
24 VDC (+ & -)	Violet
12 VDC (+ & -)	Blue
Foreign Voltage (DC)	Violet/White or Blue/White

D. Power Conductors:

1. Provide power conductors with following colors for the shown voltage:

Wire	480Y/277V, 3Ø	208Y/120V, 3Ø	240/120V, 3Ø
Phase A	Brown	Black	Black
Phase B	Orange	Red	Orange per NEC 408.3(E) and 215.8
Phase C	Yellow	Blue	Blue
Ground	Green	Green	Green
Neutral	White or Gray per NEC 210.4(D)	White	White

2. Provide black insulation conductors larger than #10 AWG with colored 3/4-inch vinyl plastic tape to identify the phase color at each cable termination. Tape wrap with 25 percent overlay to provide minimum of 3 inches of coverage.

E. Scheduled and Unscheduled Wire and Cable:

1. Provide the insulation and jacket material specified in the CABLESPEC sheets for scheduled and unscheduled (not shown) conductors. Provide stranded copper conductors for all wire and cable.

F. Electrical Enclosure Conductor Ratings:

1. Provide conductors with 600-volt insulation ratings in panels and other electrical enclosures. Conductors with less than 600-volt insulation ratings are prohibited, unless specifically identified.
2. Bundle and lace conductors in panels and electrical equipment at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Provide lacing using plastic cable ties that are tensioned and cut off using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are prohibited.
3. Bundle conductors crossing hinges into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors and provide oversized plastic panel wiring duct within panels.
4. Provide slack in junction boxes, pull boxes, handholes and manholes sufficient to allow cables or conductors to be routed along the walls with the amount of slack equal to largest dimension of the enclosure.
5. Provide dedicated electrical wireways and insulated cable holders mounted and secured on stainless steel unistrut in manholes and handholes.

G. Instrument Signal Cable:

1. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Provide twisted shielded cable with individual shield for each pair. Provide twisted shielded cable multi-pair with overall shield and jacket. Provide triads wherever 3-wire circuits are required. Circuits shall not be made using conductors from different pairs or triads.
2. Install instrument, signal, and data communication circuits without splices between instruments, terminal boxes, or panels. Shields as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables are not acceptable. Common ground return conductors for two or more circuits are not acceptable.

3. Bond shields to the signal ground bus at the control panel. Isolate shields from ground and other shields at other locations by cutting short or taping. Provide terminal strips for signal leads and shield drain wires.
4. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run. Shields or drain wires for spare circuit cables shall be bonded at control panel only with the other end insulated by tape cover.
5. Provide an instrument stand with terminal box mounted approximately 3 feet above grade to center or as shown. Provide terminal boxes for instrument cable with the cable and conductor labels specified.
6. Install and terminate conductors for paging, security, data communication, voice communication, and telephone systems in compliance with the manufacturer and the system utility recommendations.

H. Splicing and Terminating Materials:
1. Use an UL listed tool for the applied compression type of connectors with the correct size and type. Provide tin-plated high conductivity copper connectors. Mechanical clamp, dimple, screw-type connectors are prohibited.
2. Provide polymeric insulating material over motor terminations with high dielectric strength mastic or material to seal the ends against ingress of moisture and contamination.
3. Cover splices with electrical products designed for the application, and insulate with a heat-shrinkable sleeve or boot.

I. Fire Stop Sealant Materials:
1. Provide non-combustible silicone sealant for sealing apertures and cable through-penetrations for electrical conductors meeting UL 263 4-hour time-temperature requirements.
2. Manufacturer: STI Inc., Pensil Silicone Sealants PEN300 SpecSeal Firestop, or equal.

J. Circuit Numbering Marking System:
1. Identify each power, control, and signal conductor at each terminal connection. Machine print the letters and numbers with black on white alphanumeric characters representing the circuit numbering system.
2. Identify conductors, including spares. Provide cable markers and wire markers for distribution and utilization equipment circuits identifying the power source and circuit source from which it is served.
3. Provide the identification system of vinyl power cable strap-on cable markers, vinyl multi-conductor control cable strap-on cable markers, and vinyl or polyolefin wire slip-on sleeves and encircle the conductor.
4. Provide conductor marker used in outdoor, damp, or wet locations on heat-shrinkable polyolefin shrinkable marking sleeves covered with clear heat-shrink sleeve or clear tape cover.
5. Print conductor markers using the Brady Marker “XC PLUS”, the Brady LS2000 printer with the Brady sleeve wire marking system, or Engineer accepted equal.

K. Terminal Blocks:
1. Provide terminal blocks with the following features:
a. Voltage rated: 600 volts.

b. Current rated: match largest conductor connected to the assembly.
c. Integral marking strips.
d. Terminal block assemblies: provide with mounting channels, barriers, and end clamps.
e. Power and grounding terminal blocks: solderless box lug type.
f. Control and signal terminal blocks. Manufacturer: Allen-Bradley 1492-HM1GY, NEMA type, 30-ampere.
g. DIN-rail mount for direct wiring into terminal blocks.
h. Pre-printed snap-in markers.

2.11 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. CABLESPEC Sheets
1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
MIC	600	SP-OS: MULT-PR#16 Shielded (TC) with Individual Pair Shields and Overall Cable Shield	Instrument
SIC	600	P-OS: 1-PR#16SH OR 1-TR#16SH (TC)	Instrument
XHHW	600	XLP Insulated Industrial Grade Conductor	Power cable/Control
THWN-2	600	Building Wire, Control Wire	Lights, receptacles, control wire
MEPR/CPE	600	Multi-Conductor Jacketed Cable Power Cable Example: 3/C #500 KCMIL with NEC Size Ground	Power

2.12 CABLE SPECIFICATION SHEETS (CABLESPEC) – MIC

A. Cable System Identification:
1. MIC

B. Description:
1. Multiple twisted, shielded pairs, 16 AWG, with overall shield instrumentation cable, UL listed, with number of pairs as shown.

C. Voltage:
1. 600 volts

D. Conductor Material:
1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
1. Twisted on a 2-inch lay

G. Shield:
1. 100 percent, 1.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire

H. Overall Shield:
   1. 2.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

I. Jacket:
   1. 45 mil polyvinylchloride (PVC)

J. Flame Resistance:
   1. UL 1277

K. Manufacturer(s):
   1. Okonite, Okoseal-N type SP-OS; or Cooper Industries-Belden equal

L. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger test: use Form in Section 01 99 90

2.13 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
   1. SIC

B. Description:
   1. Single twisted, shielded pair or triad, 16 AWG, instrumentation and signal cable, UL listed

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
   1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
   1. Twisted on a 2-inch lay

G. Shield:
   1. 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

H. Jacket:
   1. 45 mil polyvinylchloride (PVC)

I. Flame Resistance:
   1. UL 1277

J. Manufacturer(s):
   1. Okonite, Okoseal-N type P-OS; or Cooper Industries-Belden equal

K. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90

2.14 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW

A. Cable System Identification:
   1. XHHW

B. Description:
   1. Industrial grade single conductor
   2. Sizes: 14 AWG through 750 kcmil as shown

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. NEC Type XHHW-2, 90 degrees C dry or wet, Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44, Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue

F. Jacket:
   1. None

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, X-Olene; Cablec, Durasheath XLP; or equal.

I. Uses Permitted:
   1. Power, control, lighting and outlet circuits.

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01.
   2. Testing:
      a. Test in accordance with paragraph 26 05 00.01-3.02 and Section 26 05 00.01.

2.15 CABLE SPECIFICATION SHEETS (CABLESPEC) – THWN-2

A. Cable System Identification:
   1. THWN-2

B. Description:
   1. Single conductor lighting and receptacle type indoor branch circuit conductor. Sizes: 12 AWG through as shown.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B3 or B8

E. Insulation:
   1. THWN/THHN, 90 degrees C dry, 75 degrees C wet, polyvinylchloride (PVC) with nylon jacket per UL 83.
   2. May substitute XHHW2 with XLP insulation without a jacket.

F. Jacket:
   1. Nylon

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, Okoseal-N, series 116-67-XXXX; or equal.

I. Uses Permitted:
   1. Lighting, receptacle, appliance circuits and control, no other location permitted

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90

2.16 CABLE SPECIFICATION SHEETS (CABLESPEC) – MEPR/CPE

A. Cable System Identification:
   1. MEPR/CPE

B. Description:
   1. Multiconductor Power Cable with ground conductor sized for the circuit or NEC required custom larger ground conductor sized for multiple-sets of conductors in one circuit
   2. Multiconductor Control Cable with 14-AWG minimum conductor size

C. Power Cable:
   1. Green ground conductor sized in accordance with the NEC

D. Ground Conductor Size:
   1. Multiple cable runs of multiconductor power cable shall have the ground conductor sized in accordance with NEC 250-95

E. Control Cable Type:
   1. ICEA Method 1, E-2:
      without white neutral conductor,
      without green ground conductor

F. Control Cable Identification:
   1. Conductors color coded per ICEA and conductors numbered

G. Voltage:
   1. 600 volts

H. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8, coated in accordance with ASTM B33

I. Insulation:
   1. For Power Cable: RWN/RHH, 90 degrees C dry, 75 degrees C wet, composite of ethylene propylene rubber (EPR) and chlorinated polyethylene (CPE) per ICEA S-68-516 and UL 44
   2. For Control Cable: FR-EP (XHHW-2), 90 degrees C dry or wet, ethylene propylene rubber based per ICEA s-68-516 and UL 44.

J. Jacket:
   1. Chlorinated Polyethylene (CPE)

K. Flame Resistance:
   1. IEEE 383

L. Manufacturer(s):
   1. Okonite; Cablec; or equal

M. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90

2.17 WIRING DEVICES

A. Unless specified otherwise, provide UL approved ivory wiring devices for the current and voltage ratings specified and comply with NEMA WD-1 with provisions for back wiring and side wiring with captive held binding screws.

B. Heavy Duty 120v Receptacles:
   1. Single Phase: Duplex 20-amp, NEMA 5-20R accepting NEMA 5-15P and 5-20P plugs. Cooper 5362, Hubbell 5362, or equal.
   2. Ground Fault Interrupting: Ground fault interrupting (GFI) receptacles: duplex, 20 amp, NEMA 5-20R, specification grade that accepts NEMA 5-15P and 5-20P plugs. Provide GFI receptacles outdoors and as shown, UL listed with provisions for testing and resetting. Manufacturer: Hubbell GF-5352-I, or equal.
   3. Three-Phase Receptacles and Boxes: Cooper Series 309 watertight pin & sleeve receptacles, plugs, and back boxes, or equal.

C. Switches:
   1. Indoor Switches: Quiet AC type, heavy duty, specification grade in accordance with rated capacities as required. Match the switch color and the receptacles color. Manufacturer: Cooper, Hubbell, or equal.
   2. Switches for Outdoor and Corrosive Areas: Provide 20-ampere, push-type switches; Cooper Tap-Action, Hubbell PressSwitch, or equal.
   3. LOS Switches for Outdoor and Corrosive Areas: Provide NEMA 4X lockable, push/pull-type maintained mushroom switches with stainless steel push button lockout.. Switches shall be installed in existing LOS boxes.

D. Device Plates: Provide device plates with switches and receptacles that match the area classification location.
   1. Indoor, Architecturally Finished Areas: Provide switch and receptacle device plates of stainless-steel finish. Manufacturer: Crouse-Hinds, Appleton, or equal in.
   2. Indoor, Non-Finished, Non-Corrosive: Provide switch and receptacle device plates of stainless steel finish. Manufacturer: Appleton, Crouse-Hinds, or equal.
   3. Indoor, NEMA-12 Areas: In areas designated NEMA-12, or other areas specified provide hinged covers with neoprene gaskets. Manufacturer: Hubbell, Cooper, or equal.
   4. NEMA 4X - Corrosive: In areas designated NEMA-4X, Corrosive, or other areas specified provide corrosion-resistant/marine-duty stainless steel type covers. Manufacturer: Hubbell, or equal.
   5. In-Use Covers: In areas designated NEMA-4X, Corrosive, or other areas specified, and in outdoor areas, provide in-use type weatherproof lift covers that maintain weatherproof rating with plug installed for equipment that is cord connected with plug and receptacle. Covers shall be cast aluminum. Manufacturer: Outdoor, NEMA 4X areas: In-use covers shall be Hubbell WP7, WP8, WP26, or equal. Corrosive areas; Manufacturer: TayMac Corporation 20510, Carlon E9UXXXX, Hubbell WP826XXX, or equal.
   6. Wet/Corrosive Switch Covers: In outdoor, areas, wet areas, areas designated NEMA-4X, Corrosive, or other areas specified, provide weatherproof, corrosion-resistant covers for switches to maintain weatherproof rating during operation of switch.

Covers shall have flexible bubble of silicone or neoprene rubber for switch operation. Manufacturer: Cooper, Hubbell, or equal.

7. Hazardous Areas: Device plates in hazardous areas shall be, rated NEMA 7, suitable for use outdoors and in wet areas. Manufacturer: Appleton, Crouse-Hinds, or equal.

E. Pilot Devices:
   1. Provide heavy-duty push buttons, selector switches and indicating lights: 30mm, oil-tight, NEMA 4X. Indicating lights shall be light emitting diode (LED) type lamps. Unless otherwise shown, provide push-to-test type indicating lights. Provide diode isolating type pilot indicating lights specified for remote-test. Provide red indicating lamps for "STOP" indication and green indicating lamps for "RUN".
   2. Provide 120VAC control units: heavy-duty type Allen-Bradley 800H, or equal. For 24VDC: Allen-Bradley 800T, Square-D Class 9001 Type J, or equal.

F. Load-Switching Control Relays:
   1. Heavy-duty, machine tool type for switching load such as solenoids, actuators, contactors, motor starter coils, and other devices used for remote interlocking.
   2. Contacts: 4-pole and field interchangeable to either normally open or normally closed and capable of accepting a 4-pole contact block adder.
   3. AC relays: NEMA A600 contact ratings and electrical clearances for up to 600 volts.
   4. DC relays: NEMA P300 contact ratings and electrical clearances of up to 250 volts.
   5. Manufacturer: Allen Bradley Bulletin-700, Square D Class 8501 Type X, or equal.

G. F. Logic-Level Relays
   1. Logic-Level switching solid-state logic and signal circuits:
      a. Minimum of three SPDT, silver cadmium oxide contacts rated 10-amperes-resistive at 120VAC or 28VDC.
      b. Plug-in type with heavy-duty, barrier-protected screw terminal sockets.
      c. Clear polycarbonate dust cover with clip fastener.
      d. AC models: neon lamp indicator wired in parallel with coil.
      e. Manufacturer: Idec Series RH, Square D Class 8501, or equal

H. Timing Relays:
   1. Multi-function, micro-controller based, socket mounted timing relay.
   2. Single functions:
      a. Delay on Make
      b. Delay on Break
      c. Recycle (on time first, equal recycle delays)
      d. Single shot
      e. Interval
      f. Trailing edge single shot
      g. Inverted single shot
      h. Inverted delay on break
      i. Accumulative delay on make
      j. Retriggerable single shot

3. Dual functions:
    a. Delay on make/delay on break
    b. Delay on make/recycle (on time first, equal recycle delays.)
    c. Delay on make/interval
    d. Delay on make/single shot
    e. Interval/recycle (on time first, equal recycle delays)
    f. Delay on break/recycle (on time first, equal recycle delays)
    g. Single shot/recycle (on time first, equal recycle delays)
    h. Recycle – both times adjustable (on time first)
    i. Recycle – both times adjustable (off time first)
    j. Interval/delay on make
    k. Accumulative delay on make/interval
4. Time delay range, switch selectable:
    a. Single function 0.1 second to 1,705 hours in 8 ranges.
    b. Dual function 0.1 second to 3,100 minutes in 8 ranges.
    c. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
    d. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.
5. Output: Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240VAC and 1/3-horsepower at 120 or 240VAC; double pole double threw: DPDT. Mechanical life: 10,000,000 operations and electrical life: 1,000,000 operations at full load.
6. Mounting: Magnal Plug 11-pin socket
7. Environment: -20 degrees C to +65 degrees C.
8. ABB/SSAC multifunction type TRDU time delay relay with dip-switch function setting with 12VDC, 24VAC, 120VAC, 240VAC inputs as required; Agastat, STA series; IDEC or Engineer accepted substitute.

I. Elapsed Time Indicators:
1. Elapsed time indicators shall be panel mounted, non-resettable five-digit, hour indicator, rated 120 volts, 60 Hz.

2.18 GROUNDING SYSTEM

A. Provide electrical system grounding electrode conductors, equipment grounding conductors for equipment grounding and raceways, grounding electrodes, grounding electrode conductors, connections, and bonding in compliance with the National Electrical Code-Article 250 and the National Electrical Safety Code.

B. Provide annealed bare copper, concentric stranded grounding conductors. Provide the minimum sizes per NEC Article 250 for grounding conductors or service entrance conductors, if not sized on the drawings.

C. Bond grounding conductors entering enclosures together to metallic enclosure and to metallic raceways terminating at the enclosure. Clean the conductor and enclosure metal surface at the point of connection prior to making equipment grounding connections or bond connections.

D. Provide ground grid components of #4/0 AWG bare copper conductors connected to 10-foot ground rods installed at the four corners of a building, an equipment pad, or as shown on the Drawings. Provide UFER, concrete-encased electrodes per NEC 250.52(3), by embedding conductors in concrete near bottom of footing.

E. Make connections grounding conductor connections to equipment and ground rods by bolted clamps, compression connectors, or exothermic weld connections in accordance with manufacturer's installation and testing instructions. Make connections to buried grounding connections using compression connectors or exothermic weld connections. Make connections at the ground grid test wells using bolted clamps.

F. Connect the ground grid to the following with grounding conductor specified herein or connect to the ground grid with grounding conductor as shown on the drawings:
   1. Building steel columns with #4/0 AWG bare copper
   2. Electrical ductbank #4/0 embedded conductor with #4/0 bare copper
   3. Electrical distribution or utilization equipment metal enclosures with #4/0 AWG green insulated copper
   4. Metal enclosure not containing electrical distribution with #4 AWG green insulated copper
   5. Pump/motor frames with #4 AWG bare or insulated
   6. Lightning and surge arresters using #4 AWG bare or insulated
   7. Fences and gates with #4 AWG bare or insulated
   8. Ground rods with #4/0 AWG bare copper
   9. Power utility service entrance equipment with #4/0 bare copper
   10. Equipment ground plate with #4/0 AWG bare copper.
   11. Other equipment: provide #1 AWG green insulated copper. Provide ¾" conduit protection where subject to damage.

G. Ground Rods:
   1. Ground rods: copper-clad steel, 3/4-inch diameter and 10-feet long, with threaded end for connectors or installation tools.

H. Compression Connectors:
   1. Compression connections: cast copper.
   2. Manufacturer: Thomas & Betts Company, or equal.

I. Bolted Connectors:
   1. Bolted connectors: copper. Manufacturer: Burndy, O. Z. Gedney, or equal.

J. Exothermic Connectors:
   1. Exothermic connections copper products. Manufacturer: Cadweld process or equal.

K. Equipment Ground Plate:
   1. Provide equipment ground plates embedded flush in equipment pads to provide a bolted connection between a grounding conductor from the equipment frame to the ground grid.

2. Provide ground plates of copper alloy construction and 1/2 inch, threaded bolt connections and integral #4/0 welding stud. Manufacturer: Cadweld Series B-162, or equal.

L. Raceway Ground:
   1. Install metallic conduits to provide a continuous ground path. Use insulated grounding bushings and bonded to the ground grid system in compliance with Article 250 of the National Electrical Code.
   2. Provide an equipment-grounding conductor with green insulation in all metallic and non-metallic conduit, raceway, wireway, gutter, or ductbanks.
   3. Provide an equipment grounding conductor with green insulation for size up to #6 AWG and provide green color insulation tape band for conductor size #4 AWG and larger.

2.19 POWER, CONTROL, AND METERING EQUIPMENT

A. Coordinate demolition of existing equipment and installation of new equipment with electric power utility company.

B. Comply with the power utility service entrance section standards that includes the power utility metering equipment. Coordinate the correct meter socket requirements. Submit proposed equipment to power utility for acceptance prior to submitting to the Engineer. Provide and install equipment according to power utility requirements.

C. Metering Equipment:
   1. Provide analog or digital power meter with monitoring and protection features shown or specified. Provide stainless steel sunshields for metering equipment mounted outdoors.

D. Panelboards:
   1. Provide panelboards: circuit breaker, dead front type with bus bar construction composed of individually mounted circuit breakers with screw-connection, designed to be removed without disturbing other breakers. Provide lockable, hinged door-in-door construction for flush mounted panels and hinged-trim covers for surface mounted panels.
   2. Provide tin-plated copper buss and with the current rating as shown on the panel schedules sized in accordance with UL 67 and withstand rating equal to the interrupting rating of the smallest circuit breaker in the panel. Series rated products are prohibited. Silver plated equipment is prohibited.
   3. Provide panelboards with a separate ground bus and a full capacity neutral bus. Mount neutral bus on insulated standoffs. Provide removable link connector from the neutral bus to the ground bus. Provide listed and labeled panelboard for service entrance disconnect as shown.

E. Combination Motor Starters:
   1. Provide NEMA rated for the horsepower for combination motor starters, minimum size 1, with motor circuit protector and solid-state type overload relay. Provide a reset button located on the unit door exterior.
   2. Provide adjustable motor circuit protector with magnetic only trip setting adjustable over a range of 600 to 1300 percent of full load current of the motor served. Field

adjust motor circuit protector setting per NEC and manufacture's recommendations. Provide 22,000 symmetrical ampere interrupt rating, where not shown on the power single line diagrams.

3. Provide solid-state adjustable overload relay to latch in the open position. Provide adjustable trip settings with minimum adjustable range from 85 to 115 percent of full load current of motor served. Field adjust overload setting per NEC and manufacture's recommendations.
4. Provide control power transformers with two primary fuses rated at 100,000 amperes at 600VAC and one secondary fuse rated at 10,000 at 250VAC and sized at 125 percent of the control circuit full load current. Ground the non-fused leg of the secondary circuit.
5. Provide switchboard type MTW or SIS control circuit conductors rated 90 degrees C above ambient temperature. Conductors shall be identified with tag numbers.
6. Provide motor contactor "Run" status contact and "Overload" alarm contact. Provide "Hand-Off-Auto" (HOA) and other shown selector switches with a "Auto Mode" status contact wired to terminal block.
7. Provide heavy-duty selector-switches and pushbutton and indicating lights with rating to match enclosure type. Provide control devices rated at 600VAC, 10-ampere continuous with
8. Provide start/stop pushbuttons with "Run" and "Stop" indicating lights including other control devices as shown. Provide push-to-test transformer type pilot lights or LED pilot lights. Lens color as shown on the drawings or specified herein.

F. Circuit Breakers:
   1. Provide circuit breakers: molded-case type provided for the current ratings and pole configurations as shown or as specified on the panelboard schedule and with a minimum interrupting current rating as shown on drawings or schedules, but not less than 22,000 AIC for 240 volt rated devices or 42,000 AIC for 480 volt rated devices. Series rated branch, main, or other devices are prohibited.
   2. Provide circuit breakers listed in accordance with UL 489 for the service specified and load terminals with solderless connectors. Provide bolt-on type circuit breakers. Provide circuit breakers with machine-printed, circuit number labels indicting the load served.

G. Manual Starters:
   1. Provide manual starters with horsepower rated, quick-make, quick-break, toggle mechanism with overloads in each phase. Provide NEMA-12 enclosures indoor and NEMA-4X stainless steel enclosures outdoor, process areas, and corrosive areas. Provide label for power source and load as shown.

H. Safety Disconnect Switches:
   1. Provide safety disconnect switches:
      a. Motor horsepower rated, heavy-duty, non-fusible
      b. Safety type rated 600 volts AC
      c. Ratings and fuse size as shown
      d. Rating and fuse size as required by the utilization equipment manufacturer
      e. Disconnect "open status" switch rated 1-ampere
      f. Switch operator with a positive, quick-make, quick-break mechanism

g. NEMA-12 indoor-conditioned space, or as shown
h. NEMA-4X stainless steel below grade, process areas, outdoors, corrosive areas, or as shown
i. NEMA-7 aluminum hazardous classified areas.
j. Tinplated copper products. Silver-plated products are prohibited.
k. Manufacturer: Square-D, GE, Allen-Bradley and Cutler Hammer or approved equal.

2.20 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
1. Operating and maintenance information as specified in Section 01 78 23.
2. One 11" x 17" set of drawings in a protective covering and shipped with the equipment in the internal equipment pocket at the time of equipment delivery to the project site.
3. Record documents as specified in Section 01 78 39.
4. Certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) as specified in paragraph 26 05 00.01-1.01 A 4.

PART 3 – EXECUTION

3.01 GENERAL

A. Construction:
1. Perform the work specified by Contract Documents in accordance with these specifications.
2. Coordinate the location of electrical material or equipment with the work and adjust conduit location to accommodate equipment in accordance with the accepted submittal drawings from the manufacturer.

B. Housekeeping:
1. Protect electrical equipment from dust, water and damage. Cover the exterior to keep dry. Electrical distribution equipment such as motor control centers, switchgear, switchboards, panelboards, and other power source buses shall be clean and free of dust and dirt.
2. Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction as specified in Shipment, Protection, and Storage section. Touch up scratches on equipment as specified in Coating Systems section before final acceptance.
3. Wipe clean and vacuum equipment on the inside prior to acceptance testing and energization and again prior to detailed inspection and acceptance of the work.

C. Installation:
1. Perform the installation work specified in accordance with these specifications.
a. Splices are not allowed except by permission. Submit proposed splice locations to the Engineer and Construction Manager for review prior to installation. Splices and terminations are subject to inspection prior to and after insulating and may require re-termination after inspection. Underground splices will not be allowed.

b. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. Lighting and receptacle circuits in conduits with power or control conductors is prohibited.

c. Adhere to the NEC raceway fill limitations. Provide separate conduits for signal and instrument conductors and cables.

d. Install power conductors derived from uninterruptible power supply systems in separate raceways.

e. Provide terminations at 460-volt motors by bolt-connecting the lugged connectors and insulating. Alternately, provide Tyco Electronics GelCap Motor Connection Kit by Raychem.

f. Install pre-approved in-line splices and tees with tubular compression connectors and insulate. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits.

g. Provide self-insulating tubular butt-splice type of compression connectors for terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads.

h. Adjust motor circuit protectors in accordance with manufacturer's instructions and NEC requirements.

i. Adjust motor overload device in accordance with manufacturer's instructions and NEC requirements.

D. Conductors, Wire, and Cable Installation:

1. Identify conductors at each connection terminal and at splice points with the identification marking system specified.

2. Install wire and cable into raceways, conduit, cable trays, or wireways without damaging or putting undue stress on the insulation or jacket. Provide manufacturer's recommended and UL Listed pulling compounds lubricants for pulling wire and cable. Grease is prohibited.

3. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Provide wire or cable support where wire or cable exits a raceway. Provide reusable stainless steel Kellums grips or equal product where cable support is required and where loads are removable.

4. Scratch-brush the contact areas and tinplate the connection where flat bus bar connections are made with tinplated or unplated flat bus bar. Provide non-oxide material approved for the function. Torque bolts to the bus manufacturer's recommendations.

5. Adhere to raceway fill limitations defined by NEC and the following: Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits.

6. Install pre-approved in-line splices and tees made with tubular compression connectors and insulated as specified for terminations and for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or equal splicing kits.

7. Conductors in all handholes and manholes shall have adequate slack to be tied up around the perimeter of the vault and will be suspended by insulators around the vault's perimeter as needed to support the cable.

E. Raceway Installation:
   1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
   2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes.
      a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
      b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
      c. Install exposed conduit on supports spaced not more than 10 feet apart.
      d. Install conduits out from the wall using framing channel where three or more conduits are located in parallel run.
      e. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces. Verify installation method for conduits larger than 2-inch with Construction Manager prior to installation.
      f. Install conduit in slabs that have only a single layer of reinforcing steel, under the reinforcement.
      g. Install conduits with large radii under the slab in a one-sack concrete slurry.
      h. Route conduit clear of structural openings and shown future openings.
      i. Provide conduit roofs or wall penetrations with flashing sealed watertight and fire-stop, as required to maintain the structural rating.
      j. Grout conduit into any openings cut into concrete and masonry structures.
      k. Cap conduits during construction to prevent entrance of dirt, trash, and water.
      l. Terminate exposed conduit stubs for future use with pipe-caps and provide couplings and pipe-plugs where flush with the slab.
      m. Determine concealed conduit stub-up locations from the manufacturer's shop drawings.
      n. Terminate conduit in equipment with conduit couplings with pipe-plugs flush with structural surfaces for empty conduit.
      o. Install conduit horizontally with at least 7-feet headroom clearance.
      p. Terminate conduit with fittings that ensure the NEMA rating of the enclosure and provide conduit hubs, as required heretofore.
      q. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence. Taped or painted RMC-Steel or RNC is prohibited.
      r. Provide conduit crossing structural joints with structural movement with O-Z "Type DX" or Crouse-Hinds "Type XJG-SA," aluminum, bonded, weather-tight expansion fitting of the same size and type as the conduit.
      s. Seal conduits in corrosive areas using removable mastic material.
      t. VFD motor feeder circuits shall be routed a minimum of 12 inches from any control conduits. Should they cross they shall cross at 90 degrees.

F. Underground Raceway Installation:

1. Adhere to the Power Utility underground service entrance requirement for excavation, raceways installation and termination, pads and reinforcement, backfilling, and location criteria. Provide excavation, backfilling, and concrete work as specified and shown.
2. Provide underground conduit installations that conform to the following requirements:
    a. Direct bury underground conduits that are not shown to be installed in an electrical ductbank.
    b. PVC coated RMC-steel elbows for underground to above ground transitions.
    c. Underground conduit bend radius: not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere for up to 2-inch diameter conduit.
    d. Determine conduit manufacturer's bending radius requirement for 3-inch and larger diameter conduit and use factory "long radius" ells.
    e. Underground ductbanks and direct-buried conduits: 2-feet minimum earth cover, except where shown otherwise.
    f. Concrete encased conduit:
        1) Minimum concrete thickness of 2 inches between conduits 2.5-inch and smaller.
        2) 3 inches between 3-inch conduit and larger or per NEC requirements.
        3) 1-inch between conduit and reinforcing.
        4) 3 inches over reinforcing.
        5) Embed #4/0 bare ground in the concrete encasement and installed with direct buried raceways.
        6) Standard detail or typical details shown supersede these general requirements.
        7) Provide 3-pounds of red-oxide dye-color per sack of cement for in the concrete encasement for electrical ductbanks.
        8) Provide 467-ASTM coarse aggregate size with 3-cement sacks per cubic yard concrete.
        9) Provide concrete with 28-day, 2000-psi compressive strength unless specified at higher value in the cast-in-place concrete specification.

3.02 TESTING

A. Provide electrical equipment acceptance tests in accordance with the latest version of NETA Acceptance Testing Specification for electrical distribution and utilization equipment to demonstrate that all electrical equipment is functioning as designed.

B. Test lighting system for proper function. Test wiring devices for correct connections. Test outlet grounding and polarity using a plug-in test device. Test motor control stations and control devices for proper function.

C. Test power, control, instrument, and signal conductors to verify free from grounds. Megger test all conductors with the test voltage appropriate to the conductor insulation voltage. Use a 600 or 1,000-volt megohmmeter for resistance measurements for 600VAC rated insulation and all motors. Test between conductors and from conductor to ground. Insulation with resistance of less than 10-megohms is not acceptable. Record the insulation

resistance measurements in a format similar to or on the Form 26 05 00.01-A in Section 01 99 90.

D. Pre-test conductors prior to installation, as appropriate. Replace damaged conductors. Test all conductors after installation.

E. Measure motors insulation resistance before they are connected. For 50-horsepower and larger motor, measure the motor insulation resistance at the time of delivery and after they are connected. Insulation resistance values less than 10 megohms are not acceptable. Complete the Installed Motor Test Form: 26 05 00.01-B in Section 01 99 90, for each motor after installation.

3.03 FUNCTIONAL CHECKOUT

A. Prior to energization of equipment, perform a functional checkout of the control circuit. Prior to functional testing, adjust and make protective devices operative. Energizing each control circuit and operating each control, status, alarm, protective device, and each interlock to verify that the specified action occurs. Submit a description of his proposed functional test procedures prior to the performance of functional checkout.

B. Verify motors are connected to rotate in the correct direction by momentarily energizing the motor. Prior to motor rotation test, confirm that the motor, the driven equipment, nor personnel will be damaged by reverse operation.

3.04 RECORD DOCUMENTS

A. Provide Record Drawings and documents maintained and annotated during construction. Submit drawings in accordance with Section 01 78 39 and the following.

B. Include addendum items, requests for information, change orders, and field changes posted or drawn on the Record Drawings. Include the following drawings with the Record Drawings:

1. Interconnection Diagrams specified herein.
2. Original Submittal Drawings specified herein.

C. Schedule a meeting with the Engineer in the Engineer's office to review the Record Drawings at the end of the project. Make corrections to the Record Drawings prior to re-submitting the Record Drawings to the Engineer.

D. Submit Record Drawings and Operations and Maintenance (O&M) Manuals as specified in Sections 01 78 23 and 01 78 39, to be included in the completed project Record Document Set for the Owner.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 61 13.01

PROCESS CONTROL SYSTEM GENERAL PROVISIONS FOR SMALL PROJECTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies requirements which are applicable to all process control, instrumentation, communication, and signal systems. The contractor is to supply, install and startup the equipment for a complete, functional system as shown and specified.
2. Supply and install the equipment and field instruments as shown and specified. Contractor is to coordinate directly with suppliers, sub-contractors, and owner's programmer.
3. Demolition and disposal of existing electrical cables and on-deck junction boxes. Installation of cabling and field devices. Provide connections to field devices and on deck junction boxes that support chain and flight equipment in Basins 3, 4, 5 and 6 using existing conduits. Coordination of testing and start up with Owner.
4. The above is a general summary of the major items and is not intended to be all inclusive

B. Work included:

1. Major constituents of this system shall include, but are not limited to, all materials, equipment and labor required to implement a complete and operating system of instrumentation and controls. The Contractor shall supply, install, calibrate, test, and document each system in its entirety. The Contractor shall also place the completed systems in operation including tuning loops and make final adjustments to instruments as required during plant startup. The Contractor shall provide the services of NICET certified instrument technicians for testing and adjustment activities. The Contractor shall examine the mechanical drawings and specifications to determine actual locations, sizes, materials, and ratings of process connections. The system shall include control panels containing microprocessor-based display and control devices, electronic signal conditioning equipment, programmable logic controllers, and power supplies. Field mounted equipment shall include over torque switches and hand control stations as well as motors, gear reducers, and process variable measurements. Process variables shall include, but are not limited to, flow, level, pressure, temperature, and analytical measurements.

C. Related Work:

1. Raceways, signal cables, and their requirements are specified in Division 26. Summary of work and work sequences in Division 01.

Definitions:

2. General: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1 unless otherwise specified.
3. Solid State: Circuitry or components of the type which convey electrons by means of solid material such as crystals or which work on magnetic principles such as ferrite

cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid state components or circuitry.

4. Integrated Circuit: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
5. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
6. Panel: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets, and racks.
7. Data Sheets: Data sheets as used in this specification shall refer to ISA S20.
8. Signal Types: The following types of signals are used in systems specified in this division.
    a. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.
    b. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mAdc transmission.
    c. Discrete Events: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.
    d. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.

1.02 QUALITY ASSURANCE

A. References:
    1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
    2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
API RP550	Manual on Installation of Refinery Instruments and Control Systems, Part I-Process Instrumentation and Control Sections 1 Through 13
ASME Section VII	Rules for Construction of Pressure Vessels
ASTM B68	Seamless Copper Tube
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM D883	Terms Relating to Plastics
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
IEEE 100	Dictionary of Electrical and Electronic Terms
IEEE C37.90.1	Guide to Surge Withstand Capability (SWC) Tests
ISA RP7.1	Pneumatic Control Circuit Pressure Test
ISA RP12.6	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA S5.4	Instrument Loop Diagrams
ISA S18.1	Annunciator Sequences and Specifications
ISA S51.1	Process Instrumentation Terminology
MILSPEC MIL-I-46058C	Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	General Standards for Industrial Control and Systems
NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies
NFPA 70	National Electrical Code (NEC)
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UBC	Uniform Building Code
UL 1012	Power Supplies
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983

B. Systems Integrator Responsibility:
   1. General
      a. The existing control system and instrumentation integration including field wiring, testing, start-up, and operational testing shall be performed by qualified personnel, possessing necessary equipment and experience in performing similar installations.
      b. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.
      c. The overall system performance shall be demonstrated to and accepted by Owner.

C. Process Equipment Coordination:
   1. Division 40 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.
   2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment supplier and the related processes equipment manufacturers.
   3. Contractor shall obtain a copy of the manufacturer's submittal with technical information for items of equipment not provided with, but directly connected to, the

control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Contractor shall coordinate with project subcontractors and equipment suppliers.
5. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Construction Manager for resolution before proceeding.

D. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

E. Installer:

1. Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, NICET certified technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

F. Identification of Listed Products:

1. Electrical equipment and materials shall be listed, for the purpose for which they are to serve, by an independent testing laboratory. Three such organizations are Underwriters Laboratory (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). The Independent laboratory under which a product is listed shall be acceptable to the inspection authority having jurisdiction.
2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the Manufacturer's place of assembly. All costs and expenses for such inspections shall be included in the original Contract Price.

1.03 PROJECT/SITE CONDITIONS

A. General:

1. Specified communication and process control equipment shall be modified, if necessary, to make it suitable for operation in the following ambient conditions.

B. All Areas:

Atmospheric Contaminants

Hydrogen sulfide	0.1 mg/l
Chlorine	0.01 mg/l
Ammonia	0.5 mg/l
Dust	50.0 µg/m^3

Electromagnetic Radiation

27-500 MHz	10 volts/m

C. Indoor Field Locations:

Temperature	40 to 100 degrees F
Humidity	10 to 100 percent

D. Outdoor Field Locations:

Temperature	0 to 105 degrees F
Humidity	10 to 100 percent

E. Hazardous Locations:

1. Hazardous locations shall be as specified in Division 26 and or shown on the drawings.

F. Electric Power:

1. Electric power for instrumentation and communication systems shall be obtained from the existing plant UPS system.

1.04 SUBMITTALS

A. General:

1. Procedures: Submittals shall be provided in accordance with requirements within Division 26 and Division 40. Offers of substitution for items specified by name shall be submitted in accordance with Specification requirements.
2. Deviations: A copy of each specification section in this division, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate specification compliance or marked to indicate requested deviations from specification requirements. If deviations from the specifications are indicated and, therefore requested by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further consideration.
3. Completeness: A separate submittal shall be provided for each section of this division requiring a submittal. The submittal for each section shall be bound separately and shall include all the information required for each item specified in the subject section. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

B. Additional Information:

1. Test Forms: Test report forms shall, where appropriate, conform to the requirements of reference forms 40 95 10-A through 40 95 10-K included in Section 01 99 90. Additional and/or more detailed forms shall be developed as necessary to suit more complex instrumentation. Usage of terms used on test forms shall be in compliance with ISA S51.1.

2. Data Sheets: Data sheets for all instruments and accessories to be provided shall be submitted. Data sheets shall be in accordance with ISA S20. All applicable entries on the data sheet shall be completed.
3. Drawings:
    a. General: The drawings included in this project manual are functional in nature and may not show exact locations of equipment or interconnections between equipment. Detailed construction drawings as specified below shall be provided. Drawings shall be prepared on 11-inch by 17-inch drafting media. Drawings shall have borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall carry a date and brief description of the revisions. Diagrams shall be developed using NEMA standards, carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with paragraph 3.01 B. of this section.
    b. Elementary and Loop Diagrams: Elementary diagrams shall be provided. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers. Loop drawings shall include the process, field instrument, control panel (front and behind), software functions and SCADA.
    c. Connection Diagrams: Connection diagrams for panels shall be provided. Connection diagrams shall show components of a control panel in an arrangement similar to the actual layout of the panel. Internal wiring between devices within the panel shall be shown on these diagrams. Connection diagrams shall show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such. Wiring diagrams shall indicate insulation color code, signal polarities, and shall show wire numbers and terminal block numbers.
4. PRODUCT DATA
    a. Material List: Within 60 days after "Notice to Proceed", a list of the manufacturer and model series for each major category of equipment, system, and instrument to be provided shall be submitted.
    b. Catalog Cuts: Catalog cuts showing pertinent information and features for the proposed equipment shall be provided. Catalog information shall include technical specifications and application information for each piece of equipment. Catalog cuts shall be edited to indicate only those items, model or series of equipment which are being provided. All extraneous materials shall be crossed out or otherwise obliterated. Failure to complete this specification requirement will result in the submittal being rejected with no further review.
    c. Certification:
        1) Temperature: Test data, certified by the manufacturer, shall be provided to demonstrate that field electronic devices are suitable for the specified ambient temperatures.
        2) Corrosion: Data shall be provided showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic

equipment has operated in similar environments for a period of not less than 5 years without failure due to corrosion.

d. Record Documentation: interconnection diagrams, loop diagrams, and data sheets included in paragraph 1.04 of this section, shall be provided as record drawings in accordance with Section 01 78 39. Following start-up but prior to acceptance of the work, the Contractor shall provide electronic copy on CD using ACAD format and full-size reproducible prints of elementary, loop, connection and interconnection diagrams and reproducible prints of other drawings; and PDF format for equipment data sheets. Documentation shall reflect the final constructed state of the instrumentation and control systems.

C. Operation and Maintenance Information: Operation and maintenance information shall be provided in accordance with Section 01 78 23.

D. Test Results: Test data sheets, printouts, and other records of testing as specified in paragraph 3.02 of this section shall be provided.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials and Quality:

1. Material shall be new, free from defects, and of the quality specified. Each type of instrument, instrument accessory, and device shall be by the same manufacturer throughout the work.

2.02 PROCESS SWITCHES

A. Switches shall comply with the following requirements:

1. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm.
2. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts monitored by electro-magnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300.
5. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures shall be rated NEMA 250, Type 4 minimum.
7. Contacts located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers or relays as specified in paragraph 2.09 of this section.

2.03 NAMEPLATES

A. Nameplates shall be machine engraved white phenolic with black lettering. Lettering shall be 5/32-inch minimum unless otherwise specified. Nameplate wording may be

changed without additional cost or time if changes are made prior to commencement of engraving. Name plates shall be mechanically fastened with stainless steel self-tapping screws.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Equipment shall be installed in accordance with manufacturer's instructions, NFPA 70, API RP550, this section, and as shown on the drawings. Equipment shall be located so that it is readily accessible.

1. Wiring:

a. Wiring shall comply with the requirements of NFPA No. 70 as a minimum standard. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V. Wiring channel fill shall not exceed 50 percent.

b. Interconnection Wiring:

1) Panel Interconnecting Wiring:

2) Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.

3) Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.

4) Panel power wiring: Conductors specified in Division 26 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.

5) Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.

c. Field connections shall be on separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel. Field terminals shall have no internal panel wiring attached thereto.

d. Wiring shall be tagged at terminations with machine printed plastic sleeves. Wire numbers shall consist of three parts. The prefix of the wire number shall be the respective drawing sheet number. Following the prefix shall be respective sheet rung number. The third part of the wire number shall be a number that identifies wires in a circuit that are electrically identical. The field wiring number shall consist of the terminal number the wire is landed on at each end for ease of reference.

e. Code letters and wire colors are given in the following tables:

Item Code	120 Vac Wire	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Item Code	24V DC Wire	Color
SP	Power Supply	Blue
S	Signal (+)	Black
SG	Signal Ground	White
PG	Equipment Ground	Green

f. Wire used for dry contacts that are connected to remote devices shall be Yellow in color.

g. No more than two wires shall be connected to a terminal.

h. Each panel shall have its record connection and interconnection diagrams mounted behind a piece of plexiglass on the inside of one (or more) door(s). Also provide a copy of the as-installed drawings in the enclosure print pocket.

2. Grounding: Each panel shall be provided with two copper ground bars. One bar shall be bonded to the panel frame or sheet metal and to the station ground system. The second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar. In panel line-ups exceeding 30 inches in width, ground bars shall be 1/4 by 1-inch copper bars extending the entire length of the panel.

B. Field Equipment:

1. General: Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 and 60 inches above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access but mounting shall not obstruct walkways. Equipment shall not be mounted where shock or vibration will impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Steel used for support of equipment shall be 316 stainless steel, unless otherwise specified. Support systems including panels shall be designed in accordance with Standard Building Code and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

2. Identification Tags: Each field mounted instrument or device shall be provided with a 16-gauge stainless steel identification tag. Identification tags shall bear the complete instrument number as listed in paragraph 3.04 of this section. Characters shall be 1/4 inch, die-stamped. Identification tags shall be securely attached to the equipment in a readily visible location using stainless steel screws or wire.

3.02 TESTS AND INSPECTIONS

A. General Requirements:

1. Materials, equipment, and construction included under this specification shall be inspected in accordance this section. Testing shall be performed in accordance with Section 01 45 23, and this section. No required test shall be applied without prior notice to the Construction Manager, who has the right to witness any test. At least 14 days before the commencement of any testing activity, a detailed step-by-step test procedure, complete with report forms for the recording of test results, shall be provided. All equipment necessary to perform the specified tests shall be provided.

B. Delivery Inspection:

1. The Contractor shall notify the Construction Manager upon arrival of any material or equipment to be incorporated into the work and shall remove protective covers or otherwise provide access in order that the Construction Manager may inspect such items.

C. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of reference forms 40 61 13-A through 40 61 13-K included in Section 01 99 90.
2. Test Equipment: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall be included with the test report. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.
3. Testing Stages:
   a. General: Each instrument loop shall be tested in the following sequence:

Testing sequence	Form reference
Wiring	40 61 13-A and B
Individual components	40 61 13-C through I
Individual loops	40 61 13-J
Loop commissioning	40 61 13-K

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Construction Manager prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Construction Manager prior to commencement of loop commissioning.

   b. Individual Component Calibration and Test: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure and then tested in accordance with the Contractor's test procedure.

Data shall be entered on the applicable test report form at the time of testing. Alarm trips, control trips, and switches shall be set to the initial values specified in paragraph 3.04 of this section. Final elements shall be checked for range, dead-band, and speed of response.

c. Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

d. Loop Test: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

e. If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly.

f. SYSTEM ACCEPTANCE TEST: The system test shall be executed after all component and subsystem tests have been completed and be designed to place the completed system in full operation and demonstrate that all functional requirements of this specification have been met. The system test shall, as a minimum demonstrate the following:

   1) That each component of the system operates correctly with all other components of the system;

   2) That all interlocks perform correctly;

   3) That all control sequences perform correctly;

   4) That the complete system is reliable and consistent under all conditions of plant operation.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies testing requirements applicable to Sections 40 61 13 through 40 67 00 of these specifications for the process control, instrumentation, and signal systems Section includes:
   1. Testing documentation.
   2. Testing organization and sequencing.
   3. Performance testing.
   4. Loop testing.
   5. Functional testing.
   6. Operational testing.

B. Related sections:
   1. Section 01 99 00 – Reference Forms
   2. Section 26 05 00.01 – Common Work Results for Electrical (Small Projects)

1.02 REFERENCES

A. Definitions:
   1. The term “instrumentation” covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

B. Reference Standards:
   1. This section contains references to the following documents with additional references listed in Section 40 61 13.01.
      a. References are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the referenced documents, the requirements of this section prevail.
      b. Version: Latest documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids) unless noted otherwise.
      c. If referenced documents have been discontinued by the issuing organization, use the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
      d. Where document dates are given in the following listing, reference to those documents means the specific document version associated with that date, whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ISA RP7.1	Pneumatic Control Circuit Pressure Test
ISA S51.1	Process Instrumentation Terminology

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate testing with Section 26 05 00.01.
   2. Provide notice to the Construction Manager prior to conducting a test.
   3. Coordinate, manage, and supervise the work including:
      a. Testing plan with the sequence for the test work.
      b. Calibration program for instruments and analyzers.
      c. Documentation program that records tests results.
      d. Performance testing program systems.

1.04 SUBMITTALS

A. Action Submittals:
   1. Testing submittal:
      a. Submit detailed testing plan and proposed testing documentation after review of the Quality Assurance submittal showing conformance with Part 2 of this specification. Obtain approved submittal prior to testing.
         1) Testing status spreadsheets.
         2) Loop test procedures.
         3) Control system procedures.
         4) Proposed test forms per this section, detailed for each test for this project.

B. Closeout Submittals
   1. Final Test Report submitted at the completion of the inspection and testing activities for a process area.
      a. Label to identify the project name and process area. Include in the test report the applicable test procedures for the process area and the completed inspection and test report forms associated with the equipment and systems of that area.
      b. Organize test results by equipment item or system identify each. The responsible testing entity is to acknowledge system deficiencies and noncompliant test results identified in the final test report as corrected.
      c. Test equipment and test equipment calibration date.
      d. Loop test results.
      e. Operational test results.

PART 2 PRODUCTS

2.01 GENERAL

A. Test forms: Conform to the requirements of Reference Forms 40 61 13-A through 40 61 13-K included in Section 01 99 90. Develop additional or detailed forms as necessary to suit complex instrumentation. Use terms on test forms that comply with ISA S51.1.

B. Project Labeling:
   1. The items specifying project labeling herein include the following as a minimum: Owner's name, facility name, project name, and project number.

2.02 TESTING DOCUMENTATION

A. Documentation Records:
   1. Develop a record-keeping system to document progress and completion for each task in each process area or system. Coordinate overall organization of areas and systems with overall testing required by the contract.
   2. Always keep documentation current and available for inspection on site in a location designated by the Construction Manager:
      a. List of names of Contractor's personnel associated with final construction and testing, and normal and emergency contact telephone numbers
      b. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
      c. Testing status specific to pre-loop test and loop testing status spreadsheet to include the I/O list organized by area and system and loop number. Percent complete of the PICS system will be based on percentage of I/O points tested.
      d. Test Report Volumes.

B. Test Report Volumes:
   1. Develop and maintain testing documentation for each process area or system in separate volumes. Always keep each volume current and available for inspection on site in a location designated by the Construction Manager. Include the following as a minimum:
      a. Cover page stating [Testing Documentation for (applicable) Process Area / Process System] including project labeling.
      b. Table of Contents with same labeling as the volume cover with tabs for each section:
      c. Section 1: Control Description
      d. Section 2: I/O Interface
      e. Section 3: Test Procedures and Forms
      f. Section 4: Test Report

C. Control Description:
   1. Provide a control description outlining operation for each process area's system. The Control Description Specification Section 40 61 96 may be used as a basis.

D. I/O Interface:
   1. Provide I/O spreadsheets for each process area's system. Spreadsheets are to include the following for each I/O point:
      a. Signal number/tag.
      b. Annotation description that may be logically abbreviated and that is subject to approval.
      c. Complete physical I/O channel designation and addressing or communication I/O register designation.
      d. True/false status designations for digital I/O.
      e. Indicate pass/fail for each point for both pre-loop test and loop tests.
      f. Indicate date of tests and comment for failed points.

E. Field Test Procedure Documentation:
   1. Organize and assemble test procedures for each discrete loop in the process control system in separate volumes for each process area or test group. Organize by I/O point. Submit final test records in electronic form by scanning and converting the records and files to PDF format, to preserve actual signatures and signoffs.
   2. Include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.
   3. Include test report forms for each loop, including forms for wiring, piping, and individual component tests, with the test procedure documentation. Record the actual test results on these forms and assemble them into final test reports.
   4. Preprint and populate information in the test report forms to the extent possible prior to commencing testing.
   5. Include on the test report forms:
      a. Project name.
      b. Process area associated with the equipment under test.
      c. Instrument loop description.
      d. Instrument loop identification number.
      e. Instrument nameplate data.
      f. Instrument setup and configuration parameters.
      g. Time and date of test.
      h. Inspection checklist and results.
      i. Reference to applicable test procedure.
      j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
      k. Test equipment used.
      l. Space for remarks regarding test procedure or results, observations, etc.
      m. Name, date, and signature of testing personnel.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
   1. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein.
   2. Inspect materials, equipment, and construction included under this specification in accordance with this section and subsequent sections of this division. Perform testing in accordance with this and subsequent sections of this division.

B. Test Equipment and Materials:
   1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.

C. Performance Deviation Tolerances:

1. Tolerances are specified in individual sections. Where tolerances are not specified, refer to the manufacturer's published performance specifications.
2. Calculate overall accuracy requirements for loops consisting of two or more components, by the root-summation-square (RSS) of the component accuracy specifications. Calculate and record tolerances for each required calibration point on the associated test report form.

3.02 TESTING SEQUENCE

A. Perform tests for each area or system in the following sequence:
   1. Performance testing
   2. Loop testing
   3. Functional testing
   4. Operational testing

B. Group equipment and I/O based on the relationship of the equipment to operate safely as specified, including full automatic and manual control and monitoring through the control system. Equipment and I/O in a given area or system shall pass testing prior to proceeding to the next set of tests in the sequence above.

3.03 PERFORMANCE TESTING

A. Perform tests in the order below.

B. Wiring Tests:
   1. Verify that electrical power and control cable ring-out and resistance testing has been performed as specified in Sections 26 05 00.01. Conduct wiring tests after cables have been properly terminated, tagged, and inspected.

C. Pre-Loop Testing:
   1. Test every I/O point from the field device to the termination on the I/O card in the panel.
   2. Perform tests with loop wiring complete and terminated for each point being tested between initial field device and I/O termination point.
   3. For each discrete I/O point, verify and document contact status value for both the opened and closed positions of the contact.

3.04 LOOP TESTING

A. Provide a request to perform loop testing at least 2 weeks prior to the requested loop test date. Include the following with the request:
   1. Area/system for which request is being made.
   2. Written certification that performance testing has been completed, documented, and passed for the area/system for which loop testing is being requested.
   3. Submittal numbers that define the tests and data points for the I/O to be tested. Provide updates to the I/O list or instrument calibration as an outcome of the performance testing.

B. Commence loop testing after the performance testing has been completed and documented to the satisfaction of the Construction Manager.

C. Test each instrument loop as an integrated system. Check operation from field instrument/switch to termination or receiving components to the control panel. Inject test signals at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

D. For each discrete I/O point, verify and document field contact status value for both the opened and closed position of the contact.

E. If the output control or monitoring device fails to indicate properly, make corrections to the loop circuitry or device. Repeat the test until devices and instruments operate as required.

F. Correct loop circuitry and repeat the test until the instruments operate properly.

G. Test Section 40 61 13-Form J.

3.05 FUNCTIONAL TESTING

A. Process Control Strategy/Functional Testing:
   1. Commence control strategy testing after loop testing has been completed and documented to the satisfaction of the Construction Manager.
   2. Control strategy testing, performed by the Programmer, consists of verifying the interface points between the controller I/O cards and field devices and equipment, and exercising the control strategies. Perform control strategy testing on one PLC at a time.
   3. Provide qualified personnel to immediately correct deficiencies in the work that may be encountered during control strategy testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete control strategy testing.

B. Control System Closed-Loop Testing:
   1. Commence closed-loop commissioning after the control strategy testing has been successfully completed and documented to the satisfaction of the Construction Manager.
   2. Demonstrate stable operation of each loop under operating conditions. Adjust loop tuning parameters as part of the test.
   3. Provide the loop response to a step disturbance for each loop.
   4. Adjust control loops with “batch” features to provide optimum response following startup from an integral action saturation condition.
   5. Where a loop is controlled under the direction of a PLC, the Programmer will perform the necessary adjustment of loop tuning parameters and set points, record the loop response, adjusting final elements, and ensuring total integrated loop performance as specified.

C. Functional Checkout:
   1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 45 00. Exercise the operable devices and energize the control circuit.

Operate control element, alarm device, and interlocks to verify that the specified action occurs.

3.06 OPERATIONAL TESTING

A. Perform the Operational Tests after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that functional requirements of this specification have been met. Demonstrate the following:
   1. Each component of the system operates correctly with other components of the system.
   2. Hard-wired and software equipment interlocks perform correctly.
   3. Process control sequences perform correctly.
   4. Application program performs monitoring and control functions correctly.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.01 SUMMARY

A. SCOPE: These control strategies are not intended to apportion work or responsibility for work among subcontractors, suppliers and manufacturers, but are offered as a guide for startup, and checkout. They describe how the system currently operates, and do not necessarily include every component required to make the system function. Work being performed is not to have any permanent impact on existing control philosophy. This information is for reference purposes only.

1. Control strategies describe sequential and interlocking control functions, Operator Interfaces and alarm and event logging.
2. The System Programmer has configured Operator Interfaces and HMI computer screens to show equipment status and alarming requirements for the abnormalities of the process and malfunctions of equipment. It is the responsibility of the contractor after work has completed to confirm the integrity of existing control philosophy has been maintained.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Programming: Refer to Section 40 61 13.01.

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this section prevail.

1. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ISA 5.06.01	Functional Requirements Documentation for Control Software
ANSI/ISA 101.01	Human Machine Interfaces for Process Automation

1.04 DEFINITIONS

1. Per ANSI/ISA 5.06.01:
    a. Analog Input (AI): A modulated signal received by the control system from an external device, such as a 4-20 mA or fieldbus signal from a pressure transmitter.
    b. Analog Output (AO): A modulated signal sent by the control system to an external control device, such as a 4-20 mA or fieldbus signal to a flow control valve.
    c. Discrete Input (DI): A binary signal received by the control system from an external switch, such as a 24-Vdc or fieldbus signal from a block valve's closed limit switch.
    d. Discrete Output (DO): A binary signal sent by the control system to an external on/off device, such as a 120-Vac or fieldbus signal to start a pump.
    e. Operation: A major programmed processing action or set of related actions normally consisting of one or more phases.
    f. Piping and Instrumentation Diagram (P&ID): A diagram showing the interconnection of process equipment and instrumentation used to control a process,
    g. Process Flow Diagram (PFD): A diagram showing outlines of one or more pieces of equipment and the expected flow paths for materials and utilities.
    h. Phase: The smallest element of procedural control that can accomplish a process-oriented task. A phase may be comprised of steps.
    i. Step: Sequential action of control devices within a phase.
2. Per ANSI/ISA 101.01:
    a. Control System: A system that responds to input signals from the equipment under control and/or from an operator and generates output signals that cause the equipment under control to operate in the desired manner.
    b. Human Machine Interface (HMI): The collection of hardware and software used by the operator or other users to monitor and interact with the control system and with the process via the control system.
    c. Supervisory Control and Data Acquisition (SCADA): A system for monitoring and control of process which are geographically widespread. This includes all equipment and functions for acquiring, processing, transmitting, and displaying the necessary process information.
3. For the purposes of this section, "Existing" refers to those structures, devices, or items of equipment which were a part of the process system prior to the work done under this Contract

1.05 ADMINISTRATIVE REQUIREMENTS

A. The control strategies are not intended to apportion work or responsibility for work among subcontractors, suppliers and manufacturers, but are offered as a guide for programming, startup, and checkout. The control strategies describe how the system is to operate, and do not necessarily include every component required to make the system function.

1.06 SUBMITTALS

A. ACTION SUBMITTALS:
    1. Conformance with specification per Section 40 61 13.01.

B. CLOSEOUT SUBMITTALS:
   1. Provide control strategies as record included in testing per Section 40 61 21.

PART 2 NOT USED

PART 3 EXECUTION

3.01 CONTROL STRATEGIES

A. The following control strategies are included in this section and describe general control features for all systems.

Control Strategy Number	Title
1	Chain and Flight Mechanism

Refer to related sections for detailed process control system descriptions.

Control Strategy 1
Chain and Flight Mechanism

A. Reference Drawing:
   1. All P&IDs, electrical control diagrams, and manufacturer drawings.

B. System Description:
   1. The Jordan Valley Water Treatment Plant Chain & Flight mechanisms consist of a series of motors, gear reducers, sprockets, chains, flights, process switches and hand control switches.
   2. Process switches integral to manufacturer drive units are tripped when excess torque occurs at the chain and flight.
   3. There is an HOA switch located at the MCC, and a local hand station lock out stop switch located in the field at the drive motor. The lock out stop switch must not be engaged and the HOA at the MCC must be in either 'Hand' or 'Auto' for the drive motor to be able to be energized.

C. Control Descriptions:
   1. Local Manual Control:
      a. The lock out stop switch must not be engaged, and the HOA at the MCC set to 'Hand' for local manual start/stop function of the chain and flight.
   2. Local Auto Control:
      a. Not Applicable.
   3. SCADA Manual Control:
      a. The lock out stop switch must not be engaged, and the HOA at the MCC set to 'Auto' for automatic start/stop function of the chain and flight. An operator may manually/remotely energize the chain and flight mechanisms via SCADA.
   4. SCADA Auto Control:
      a. The lock out stop switch must not be engaged, and the HOA at the MCC set to 'Auto' for automatic start/stop function of the chain and flight. SCADA will energize the chain and flight mechanism as appropriate.
   5. Interlocks and Permissives:
      a. Refer to the P&ID, elementary diagrams.
   6. Alarms:
      a. Refer to the P&IDs.

End of Control Strategy 1

END OF SECTION

SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies requirements for panels, cabinets, consoles, and termination cabinets for equipment for the JWWTP Solids Equipment Upgrade Project per the Panel Schedule herein.
2. Provide the instrument, control, and monitoring features indicated on the P&ID and electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring, in accordance with NEC Article 409. It shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label. Panels shall be labeled in accordance with Article 409 of the National Electrical Code.
3. Transmitters, and other equipment or devices as specified in other Division 40 sections.
4. Panels that contain programmable logic controllers (PLC) and operator interface stations (OIS) units shall be as indicated in the Panel Schedule.
5. PLC and OIS shall comply with the specified in Division 40. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
6. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
7. Vendor and Manufacturer panels specification Sections are referenced in the Panel Schedule and specify specific requirement for these panel. Contractor custom panels are specified herein and shown on the drawings.
8. The Vendor / Manufacturer package equipment and Contractor custom field panels shall adhere to the requirements in specifications Section 26 09 16 for motor starters, controllers, and devices and the circuits shall be arranged for Fail-Safe wiring and electrical operation, as defined hereinafter.

B. Panel Design:

1. General:
   a. Panel hardware and software is specified in other Sections within Division 40.
2. Control Power Distribution:
   a. Panel containing 120-volt powered equipment shall use the din-rail power distribution method with fuses and blown fuse indication.
3. Panels containing voltages greater than 480 Vac shall be separated from the control section by physical barrier.

4. Electrical Control Devices:
    a. Pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section shall comply with the requirements of Section 26 05 00.01.

C. Control Panel Schedule:

	Panel No.	Spec / P&ID	Features *	Enclosure Type	Short Circuit Current Rating	Panel Title	E-Dwgs / Notes
1	LP3001	40 67 00 / I-01-001	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
2	LP3101	40 67 00 / I-01-001	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
3	LP3201	40 67 00 / I-01-001	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
4	LP3301	40 67 00 / I-01-001	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
5	LP3401	40 67 00 / I-01-001	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
6	LP3501	40 67 00 / I-01-002	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
7	LP3601	40 67 00 / I-01-002	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
8	LP3701	40 67 00 / I-01-002	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
9	LP3801	40 67 00 / I-01-002	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
10	LP3901	40 67 00 / I-01-002	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
11	LP4001	40 67 00 / I-01-003	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
12	LP4101	40 67 00 / I-01-003	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
13	LP4201	40 67 00 / I-01-003	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
14	LP4301	40 67 00 / I-01-003	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
15	LP4401	40 67 00 / I-01-003	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
16	LP4501	40 67 00 / I-01-004	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
17	LP4601	40 67 00 / I-01-004	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
18	LP4701	40 67 00 / I-01-004	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
19	LP4801	40 67 00 / I-01-004	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor
20	LP4901	40 67 00 / I-01-004	C, 2	NEMA-4X	V	Lock Out Stop Handstation	Outdoor

FEATURES Legend

V* - Vendor / Manufacture Panel per equipment specification requirements

C* - Contractor Custom Panel as shown

1. *Programmable Logic Controller (PLC) or Remote I/O devices
2. *Panel mounted Operator Interface Station (OIS)
3. *Hardwired control logic required
4. *Windowed outer door and inner door for displays or devices.
5. *UPS
6. *Fans
7. *Heating
8. *Air Conditioning
9. *Sun/Rain Hood

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
3. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations
NFPA 79	Electrical Standard for Industrial Machinery
NFPA 70	National Electrical Code (NEC)
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL 497-1995	Standard for Protectors for Paired Conductor Communications Circuits
UL 1012	Power Supplies
EIA RS-310C	Racks, Panels, and Associated Equipment
UL 1449	UL Standard for Safety for Surge Protective Devices

4. This Section references other sections with associated work specified therein:
   a. Section 26 05 00.01 specifies raceways, conductors, and device requirements.
   b. Section 40 61 21.
   c. Section 40 61 96.

B. Listed Products:
1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
2. The control panels shall have factory applied UL 508A labels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.
3. All panels shall be labeled in accordance with NEC Article 409.

C. Shipment, Protection and Storage:
1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00.

1.03 SUBMITTALS

A. General:

1. Submittals and transmittal procedures for submittals are defined in Section 01 33 00. Submit In accordance with the procedures set forth in the General Conditions of the Contract Documents and Section 01 33 00 that include drawings, information and technical data for equipment and as required in Section 40 61 13.01. Submittal information shall be included in one complete submittal.

   a. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

      1) A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.

      2) The Owners Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.

      3) Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

   b. A marked copy of specification Section 40 61 13.01.

   c. A marked copy of specification Section 40 61 21.

   d. A marked copy of specification Section 40 61 96.

   e. A copy of the contract document Process and Instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

   f. Marked contract document Control Schematic diagrams related to the submitted equipment.

   g. Marked contract document Control Single Line diagrams related to the submitted equipment.

   h. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.

   i. List of miscellaneous items, cables, spare and replenishment parts, and chemicals to be provided, including MSDS information.

   j. Dimensioned drawings:

      1) Exterior panel and layout

      2) Interior devices and layout

      3) Door-in-door construction devices, where required

k. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.

l. Nameplate engraving schedule:
   1) Indicate engraving by line
   2) Character size
   3) Nameplate size
   4) Panel and equipment tag number and description

m. Wiring drawings:
   1) Schematic diagrams
   2) internal wiring diagrams
   3) Connection diagrams
   4) Power and control single line diagrams to comply with NEC Article 409.

1.04 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.01.

PART 2 PRODUCTS

2.01 FABRICATION

A. General:
   1. Panels shall be designed for the seismic requirements of Section 40 61 13.01. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
   2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
   3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
   4. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.
   5. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

B. Panel Layout:
   1. Provide 20 percent spare contiguous sub-panel area for future expansion.
   2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, 10 discrete, and 10 power.

3. Separation between the power components (over 120Vac) and the control / instrument components (120Vac and less) by locating the power components and the control / instrument components in separate sections of the cabinet enclosure.
4. Power cabinet section and the control / instrument cabinet section with separate door handles.
5. Separation between the power components and the control / instrument components using barriers.
6. External lockable circuit breaker handle for the main panel disconnect.
7. Individual power and control components with internal circuit breakers, as required.
8. Motor controllers, as required by the equipment specifications.
9. Displays with door-in-door construction accessible by opening the cabinet outer door.
10. Face-mounted equipment flush or semi-flush with flat-black escutcheons.
11. Panel tops of wall-mounted panels: mounted at the same elevation.
12. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
13. Panel inner door contains a drawing holder.
14. Panel drawings enclosed in a transparent, protective jacket.
15. Panel functions as specified.
16. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.
17. Wall mounting of panel weighs less than 100 pounds, where wall space is available,

C. Enclosures:
1. Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.
2. Manufacturer:
a. Hoffmann Enclosures, Inc.
b. Rittal.
c. or approved equal.

2.02 ENVIRONMENTAL CONTROL

A. Environmental controls shall be provided as required to maintain the environmental ratings of the enclosed components and shall maintain the NEMA enclosure rating as required by its location.

B. Heating: Panels located in unconditioned areas or outdoors shall be provided with thermostatically controlled space heaters as required to maintain the panel temperature 10 degrees F above ambient to prevent condensation within the panel. Space heaters with surface temperatures that exceed 120 degrees F require an expanded metal guard. Thermostats shall be Honeywell T631 series, Johnson Controls A28AA-4, or equal.

C. Ventilation: Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.

D. Air Conditioning: Systems shall not exchange cabinet interior air with ambient air.

1. The cooling system shall be either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for heat load and ambient temperature conditions.
2. Panel air conditioner coils shall be Heresite, or equal coated and protected from corrosion.

2.03 PROTECTION COATING AND FINISH

A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.04 NAMEPLATES

A. External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

D. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.

E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.05 PANEL FEATURES

A. Interconnection Wiring: Panel Interconnecting Wiring:
   1. Panel control wiring: Single conductor stranded copper NEC rated Type MTW No. 16 AWG minimum(rated 10 A per NFPA 79, Table 12.5.1), with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
   2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
   3. Panel power wiring: Conductors specified in Division 26 and meet the NEC requirements for power including phase, grounded, and grounding conductors.
   4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame retardant plastic wiring channels.
   5. Wiring channels shall comply with UL 94, Type V.
   6. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50% maximum fill.
   7. Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

B. Conductor Identification:

1. Wiring shall be tagged at every termination with machine printed plastic sleeves or pre-printed self-sticking labels as manufactured by W.H. Brady, 3M, or approved equal. No hand-written labels are permitted.
2. Three-part wire numbers for instrument and control panel internal conductors:
    a. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
    b. Part-2: Code letter and wire colors per the following tables.
    c. Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	[Blue]
PS	12 Vdc Power	[Violet]
S+	Signal (+)	Black]
SG	Signal Ground	White
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	[Yellow]

C. Conductor Installation And Protection:
1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
2. Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
3. No more than two connections shall be made to one terminal.
4. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
5. Terminal blocks shall be;
    a. Buchanan 0621-1
    b. Allen-Bradley 1492-HM1 600 V 30-amperes, finger-safe terminal block.
    c. Allen-Bradley 1492-CD3 600 V 35-amperes with #8 screw terminal block for ring or spade terminals.
    d. Phoenix Contact or Weidmuller, or equal products. Phoenix Contact or Weidmuller, or equal products.

D. Field Wiring:
1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.

E. Fail-Safe Wiring:
   1. Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

2.06 ALARM AND TROUBLE DETECTION

A. The equipment control system shall incorporate a non-energized, open-state, output contact to activate on an alarm or trouble condition or on loss-of-power. Detection of a critical alarm or trouble condition shall cause the control system to initiate the shutdown or the operation of the equipment's controlled components to achieve a "Fail-Safe" condition.

B. Devices that signal an alarm or a trouble conditions shall latch in the alarm position and require a manual reset at the equipment control panel.

C. Alarm and trouble output shall:
   1. Open an output dry-contact.
   2. Remain open until manually reset.
   3. Not indicate abnormal condition when the equipment shutdown manually or automatically.
   4. Indicate the alarm at the equipment control panel.

D. Fail-Safe Design and Operation:
   1. Failure of part of a system shall not result in the failure of the rest of the system.
   2. Failure of equipment or process shall not propagate beyond the failing device or equipment component.
   3. Control design and operation shall prevent improper system functioning due to a circuit malfunction or operator error.
   4. Control system design shall cause the controlled equipment to operate in a safe mode in the event of loss-of-power or the failure of a control system component.]

2.07 CONTROL DEVICES [NOT USED]

2.08 INDICATING LIGHTS [NOT USED]

2.09 PANEL GROUNDING

A. Each panel shall be provided with two copper ground bars.
   1. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
   2. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.

B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

E. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.10 PANEL DRAWING PROTECTION

A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.11 SPARE PARTS

A. The following spare parts shall be provided:
   1. Ten each of each type of light bulb used in the panels.
   2. Five each of each type and rating of fuse used in the panels.
   3. Five each of each type primary protector surge suppressor used in the panels.
   4. Two each of each type of surge protective device used in the panels.

2.12 PRODUCT DATA

A. The following data shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal and separate record of all final configuration, jumper, and switch settings.
   2. Test results as specified in Section 40 61 21-2.02.
   3. [Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.
   4. Special requirements for delivery of the information such as time, manner, place, or quantity.
   5. Installation and training forms specified in Part 3.

PART 3 EXECUTION

3.01 GENERAL

A. Floor mounted cabinets shall be mounted and shimmed to precise alignment so doors operate without binding. Sealant shall be provided for conduit entering the panels.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with Section 40 61 13-3.01 Field Equipment.

C. Terminals and terminal blocks shall be sprayed after all terminations have been completed with a silicone resin conformal coating, Fine-L-Coat Type SR, Dow Corning, or equal..

D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind plexiglass holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

E. Verify that all panels have been labeled with Arc Flash warning labels per NEC 110.16. Provide labels, with Arc Flash protection boundary and PPE levels, in accordance with Section 26 05 00.01.

3.02 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Center-line of wall-mounted panels shall be 48 inches above the floor.

G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

3.03 FIELD TESTING

A. Field verify the following for Instrument and Control Panels:
   1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
   2. Control contacts installed in the ungrounded side of the circuit.
   3. Barriers between the power wiring and the signal and control wiring.
   4. Connected to the plant grounding system, as specified.
   5. Inner door contains a copy of the Record elementary and wiring diagrams, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.
   6. Panel Functions as specified.

7. Mounted with stainless steel unistrut, fittings, and fasteners.
8. Tested in accordance with Section 26 05 00.01 and Section 40 61 21.

END OF SECTION

SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. Equipment Lists:

1. Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

A. Arrangement:

1. The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The Contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.5	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)

C. Unit Responsibility:
   1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

D. The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.5, Class 150. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS [NOT USED]

2.03 GUARDS [NOT USED]

2.04 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "Caution - Automatic Equipment May Start At Any Time". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.05 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.06 LUBRICANTS [NOT USED]

2.07 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the following.
   1. Anchor bolts for equipment shall be designed by the Contractor Engineer, licensed in the State of Utah, to include operational loads with seismic forces.
   2. All anchors shall be adhesive anchors in accordance with Section 05 05 20.

PART 3 EXECUTION

3.01 GENERAL

1. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 46 43 76

INCLINED PLATE SETTLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Inclined plate settlers and all appurtenant work, complete and operable, in accordance with Contract Documents for:
   1. The retrofit installation of plate settlers in four (4) existing sedimentation basins (Basins 3-6); basins are uncovered, exposed to the elements, and may be offline or operating in the winter.
   2. Supports throughout each basin for a 4-axle chain & flight solids removal system.

B. One Plate Settler Manufacturer (Manufacturer or Supplier) shall supply all equipment specified in this Section.

C. Requirements include design and fabrication of supports and individual inclined plate pack assemblies for a complete and operable system for installation in concrete basins as shown on the drawings and specified herein.

D. Plate pack assemblies shall include the following manufacturer-supplied items: plates; frames; troughs; flow control baffles; embedment pieces; support columns; support beams; supports for chain & flight equipment; anchor assemblies; and bolts for attachment to steel and concrete support systems within the basins indicated on the drawings and specified herein.

1.02 RELATED SECTIONS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 80: Environmental Conditions
   2. Section 01 33 00: Submittal Procedures
   3. Section 01 73 24: Design Requirements for Non-Structural Components and Non-Building Structures
   4. Section 01 78 23: Operation and Maintenance Data
   5. Section 01 79 00: Demonstration and Testing
   6. Section 05 05 20: Anchor Bolts
   7. Section 05 50 00: Metal Fabrications
   8. Section 43 05 11: General Requirements for Equipment

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the

requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AISC 341	Specification for Structural Steel Buildings
AISC 360	Seismic Provisions for Structural Steel Buildings
AISC 370	Specification for Structural Stainless Steel Buildings
ANSI/NSF 61	Drinking Water System Components
ASTM A36	Standard Specification for Carbon Steel
ASTM A167	Standard Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet and Strip
ASTM A267	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A320	Alloy Steel Bolting Materials for Low Temperature Service
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet and, Strip
AWS D1.1	Structural Welding Code – Steel
AWS D1.6	Structural Welding Code – Stainless Steel
IBC	International Building Code (with Local Amendments)

1.04 SUBMITTALS

A. All submittals shall be as specified in Section 01 33 00. Note that the Contractor will need an approved submittal early in the project to meet interim project milestones.

B. Product Data and Calculations
   1. Design calculations to substantiate the proposed plate settler and plate settler support designs. Calculations shall include at least the following:
      a. Plate area calculations.
      b. Detailed hydraulic calculations, including a hydraulic profile, at design flow and peak hydraulic flow rates, across the inclined plate settlers showing the water surface elevations in the sedimentation basins upstream of the plate packs, through the effluent troughs, and into the settled water channel at the point of connection with the effluent troughs. Hydraulic calculations shall also include effective hydraulic loading rates of the units and flow velocities between plates and between rows of plate packs; flow velocities throughout the unit (feed box velocities, plate influent velocities, and plate velocities).
      c. Headloss through unit.
      d. Water surface elevations upstream of the effluent weir, in the effluent trough and in the sedimentation basin. Show these elevations on the submittal drawings.
      e. Effective hydraulic loading rates of unit.
      f. Maldistribution CFD model results.
      g. Weight of the equipment and its distribution on the supports for worst-case design conditions.
   2. Structural Calculations
      a. The Contractor shall cause the Supplier shall submit complete structural calculations stamped and signed by a Structural Engineer registered in the state of Utah, in accordance with Section 01 33 00. The calculations shall

demonstrate full compliance with the structural requirements specified for this Project in this Section, on the Drawings and in Section 01 73 24.

b. Structural modifications have been designed for the following loads due to the Plate Settler Equipment.
   1) The maximum lateral load at each beam-to-wall connection: 20 kips
   2) The maximum lateral load at each plate-pack-to-end-wall connection: 20 kips
   3) Sufficient cross bracing may be provided to maintain loads in the walls below the maximum loads specified above. Cross bracing shall only be used in the horizontal plane of the support beams and in the vertical plane of the curb walls between chain & flight mechanisms; cross bracing shall not interfere with the chain & flight equipment or return rail supports, and shall not pass under the plate pack or block ports on the side of the plates.
   4) If the support design exceeds the above limits and additional structural modifications to the concrete basins are required beyond what is already shown in the Contract Documents, Contractor shall bear the cost of any resulting modifications to the chain & flight equipment to accommodate Supplier's support design.

C. Shop Drawings: Submit drawings and descriptive data of inclined plate settlers and supports for review. Sufficient information shall be provided to show equipment conforms to specification requirements and allows for proper installation of equipment by Contractor. This includes, but is not limited to the following:
   1. Complete dimensional, and installation drawings and details.
      a. Elevations of weirs, flumes, troughs, and other controls;
      b. Materials and details of construction;
      c. Pertinent manufacturer's data and details of special features;
      d. Load distributions for the plate packs onto the supports (for the worst case design condition)
      e. Certified dimensional drawings for plate settlers and support system. Include support anchor bolt and anchorage details.
      f. Fabrication drawings, including weld types.
   2. Diagram of the system that details which part of the equipment is completely submerged during normal operation and at the air/water interface.
   3. Flow diagrams of system showing location of equipment and devices;
   4. Parts list and other materials,
   5. Recommended shipping and storage procedures.
   6. Installation details and procedures identifying acceptable methods of lifting, lateral movement, leveling, and anchoring.
   7. Material data sheets.
   8. Conformance with ANSI/NSF 61 classification.
   9. Cross sections and details, as required, to satisfy Engineer and Contractor for the detailed design and location of all connecting or adjacent structural and mechanical items such as foundation, anchor bolts, steel and concrete supports, piping, conduit, etc.

10. Any recommended or required deviations from the dimensions and locations of connecting or adjacent items as shown in the Drawings shall be described completely in the submittal.
11. O&M data per Section 01 33 00 is required prior to submittal of Owners manuals.

D. Experience and References:
   1. Provide documentation indicating manufacturers qualifications as outlined in Section 1.04 A of this specification. Provide contact name and phone number for reference on previous projects.

E. Welder certifications from a recognized testing laboratory demonstrating that the plate pack welders are qualified and experienced in welding stainless steel; and will demonstrate testing of welders using different types of welds, welding positions, etc.

F. Installation Manuals: The Inclined Plate Settler Manufacturer shall provide electronic copies of written Installation Manuals. The installation manuals shall provide complete and clear field erection instructions as well as recommended storage procedures prior to installation. The installation manuals shall be submitted at least two (2) weeks prior to shipping the first set of plate packs to the Project Site.
   1. Installation procedures identifying acceptable methods of lifting, lateral movement, leveling, and anchoring. Also include procedures for connecting the plate pack units to one another and to the settled water channel.

G. Owner's Manuals: The Supplier shall submit Owners Manuals in accordance with Section 01 78 23. The manuals shall address the following areas:
   1. Brief description of inclined settling plate components;
   2. Routine maintenance and cleaning procedures;
   3. Operation and maintenance instructions, parts list, illustrations and diagrams.

1.05 QUALITY ASSURANCE

A. Manufacturers Qualifications:
   1. Experienced in the production and manufacture of substantially similar equipment during the 5 years prior to the issuance of this contract, and able to submit reference contact information and evidence of satisfactory operation in at least 4 different installations with winter ambient temperatures below freezing in uncovered basins and with effluent performance meeting or exceeding the requirements as outlined in Section 2.03 of this specification.
   2. Plate settler manufacturer to provide support system, troughs, plate settler modules, and all other components required providing a complete and operational plate settler system. All components shall be provided by a single manufacturer. The support system shall include all frames, columns, beams, and cross bracing required for a complete installation.
   3. The manufacturer shall be solely and fully responsible for the warranty, hydraulic and mechanical design adequacy of all the provided components under this section.

B. Shop Inspection:
   1. Shop inspection may be required by the Owner at its own expense. The Supplier shall give at least three (3) weeks' notice to the Construction Manager prior to beginning of

any fabrication work so that inspection may be provided. The Supplier shall furnish all facilities for the inspection of materials and workmanship in the shop and inspectors shall be allowed free access to the necessary parts of the works. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of these Specifications. Inspection at the shop is intended as a means of ensuring high quality workmanship and of facilitating the work, but it is expressly understood that it will in no way relieve the Supplier from responsibility for furnishing proper materials or workmanship under this Specification.

2. Plate pack units shall be completely assembled in the shop to assure accurate plate spacing

C. Workmanship

1. Workmanship in the fabrication of the inclined plate settlers shall be first-class, including the following requirements. The assembled plate packs shall have members that are straight and true. Structural distortions, warps, and other defects shall not be present in the plate pack assemblies before or after installation in the sedimentation basins. All exterior surfaces and edges of the plate packs shall be smooth. Sharp corners shall be ground round and smooth.
2. All welding shall be done in accordance with the latest applicable code and other pertinent standards of the American Welding Society (AWS). Qualification of welders shall be in accordance with AWS standards. Welding of stainless steel shall be performed by welders experienced in stainless steel welding. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS Code. Upon completion of welding, all weld spatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workman- like appearance, with uniform weld contours and dimensions. Finished welds shall be neat in appearance.

D. Warranty Bond

1. Contractor shall cause Supplier to provide a three year warranty bond to guarantee system performance for all aspects defined in this specification. In the event that Supplier is not able to meet the performance requirements specified herein, and is not able to remedy installation, Owner will use the warranty bond to either accept the defective system or remedy the system themselves.

1.06 DELIVERY, STORAGE AND HANDLING

A. Supply Requirements: The plate settler supports, including supports for the chain & flight system, are an integral part of the Contractor's Work; delivery of the support system is critical for the overall project. Contractor shall include a provision in its agreement with the Supplier that the Supplier will pay the Contractor liquidated damages for each Milestone described in this subsection that is not met. The amount of liquidated damages in the agreement for each milestone shall not be less than $1,000 per day for Milestone 1, $2,000 per day for Milestone 2, and $1,000 per day for Milestones 3 and 4. The agreement between the Contractor and Supplier shall include an exception to liquidated damages if delay is due to a force majeure event limited to acts of God or of the public enemy, fire, floods, quarantine restrictions, strikes, labor disputes, sabotage, or freight embargoes.

1. Milestone 1: December 1, 2022; provide the entire support system for Basins 3&4;

2. Milestone 2: February 1, 2023; provide the entire support system for Basins 5&6;
3. Milestone 3: October 1, 2023; provide the entire plate system for Basins 3&4;
4. Milestone 4: December 1, 2023; provide the entire plate system for Basins 5&6;

B. Packing and Shipping: Pack as required for shipping and outdoor storage at the project site for up to 6 months. Provide lifting lugs or other means for unloading and/or installation. Include special handling instructions and provide picking spreader as needed. Plate settlers shall be shipped with external protection as needed to protect plates from damage, including road salt, during shipping and storage.

C. Storage and Protection: The Contractor will prepare the staging area for storing plate packs. The area shall be as designated on the Drawings. The storage area shall be graded with aggregate rock to form a firm, well-draining storage area. Plate packs shall be covered and kept clean at all times.

D. Protect finished surfaces which may be damaged during installation with removable tape or suitable alternate.

1.07 SPARE PARTS

A. Special tools as required for assembly or disassembly of the plate settlers and support system.

B. Spare parts as recommended by the manufacturer packed in containers which are clearly identified as to their contents. Pack all items for long periods of storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Provide equipment as manufactured by the following:
1. Jim Myers and Sons, Inc. (JMS).
2. Meurer Research, Inc. (MRI).

B. Plate design shall have been used in a minimum of 5 installations.

2.02 SYSTEM DESCRIPTION

A. One Inclined Plate Settler Manufacturer (Supplier) shall supply all equipment specified in this Section.

B. Plate settler equipment, including plate modules (or packs), frames, effluent troughs, and support system shall be installed in Basins 3 through 6 at the Jordan Valley Water Treatment Plant (JVWTP) in Herriman, Utah.
1. Each plate settler system shall be installed in an uncovered sedimentation basin for the purpose of removing solids from water.

C. Basis of Design

1. The structural and mechanical design for the inclined plate settlers are based on information provided by the listed Inclined Plate Settler Manufacturers. Fundamental changes in the configuration of the plate settler system will not be allowed.
2. Process Design:
    a. Plate packs shall be protected by a curb or apron to prevent the water surface from submerging the plates at maximum hydraulic flow rate.
    b. The maximum feed velocity into the plate pack shall be 0.5 ft/sec to prevent floc destruction and hydraulic disturbances.
    c. Feed through the bottom end of the plate shall be minimized to prevent solids re-entrainment.
    d. Troughs shall be designed to allow a maximum of 5 inches of headloss as flow passes from plate settlers into effluent troughs over a weir at the design flow rate.
    e. Effluent troughs are to be located on each side of plate packs to prevent maldistribution. After exiting the plates, water shall travel no more than ½ of a plate width to reach an effluent trough. Effluent troughs shall be of the dual side-loaded design and be located on both sides of the plate settler frame assembly.
3. Structural Design:
    a. The structural design of the plate settler system shall be in accordance with the requirements of the International Building Code (IBC).
    b. Plate settlers, frame, supports, troughs, and anchorage system shall be designed per the environmental conditions specified in Section 01 11 80. Inclined Plate Settler support frames shall be designed for the worst-case load condition of an empty basin and full effluent troughs. The effluent troughs shall be designed such that maintenance personnel can walk in/on the troughs when the troughs are empty.
    c. Plate settlers, frames, supports, troughs, and anchorage system shall be designed per seismic, snow, and wind criteria specified in Section 01 73 24.
    d. Additionally, the support frames and columns shall be designed for the live and dead loads to support the chain & flight return rail and the respective 4th axle systems. Plate settler supplier shall coordinate with Chain & Flight supplier (Evoqua) to design supports for the return rails and 4th axle; see Evoqua's approved submittal nd final shop drawings in Volume IV of the contract documents for information needed to complete the 4th axle support design.

D. Inclined Plate Settler Design Criteria:

Service	Surface water from the Provo River
Operations (normal)	24hr/day April – October Offline and drained Nov. - April
Operations (extended)	24hr/day, 365 days/yr
Number of Basins	4
Nominal Inside Basin Width (ft)	60

Inside Basin Length (ft)	360 total (114 in the forebay [aka, short side], 234 in the aft bay [aka, long side])
Side Water Depth (ft) at Design Flow	13.37
Weir elevation (ft)	13.25
Minimum Flow (mgd) per Basin	10
Design Flow (mgd) per Basin	33.5
Peak Hydraulic Flow (mgd) per Basin - plate settlers must pass this flow without submerging the plates; this is not the design process flow	40
Design Loading Rate (gpm/ft^2)	0.35
Plate Efficiency, %	80%
Minimum Effective Projected Horizontal Surface Area (ft^2) per Basin, Total	83,032
Minimum Effective Projected Horizontal Surface Area (ft^2) per Basin at efficiency rating, Nominal	66,426
Minimum Plate Thickness (in.)	0.025 (24 Gauge)
Nominal parallel distance between plates (in.)	2.00
Plate Inclination Measured form the Horizontal	55 degrees
Plate Width (ft)	4.5
Minimum number of plate rows per basin	6
Minimum number of plate packs per row	7
Number of effluent troughs per basin	9 (1 inside & 2 outside for each of 3 groups of two rows)
Minimum Clearance Between Bottom of Plate Pack and Basin Floor (ft)	6.5 (6'-6")
Minimum/Maximum Dose of Primary Coagulant (mg/L) – System shall be compatible with all ferric- and aluminum-based coagulants	2 – 50
Raw Water Characteristics Prior To Flocculation	
Temperature, Fahrenheit	33 – 80
Turbidity, NTU	2 – 100
pH	6.0 to 9.0

E. Basin Geometry:

1. Each sedimentation basin is approximately 60-feet wide and 360-feet long; each sedimentation basin has a long side (aft bay, or after the cross-collector channel) and

a short side (fore bay, or before the cross-collector channel). Plates will be installed on the long side only over chain & flight solids removal equipment in a 4-axle configuration to elevate the return flights several feet as defined in Volume IV of the contract documents above the lower scraping flights. Supports will be installed in both the long side and short side to support the chain & flight return rail and the 4th axle. Plate Supplier's design for the support system shall accommodate the Chain & Flight supplier's spacing, loads, forces, axle mounts, etc., for a complete and coordinated design.

2. The rows of plate packs and each plate pack within each row shall be laid out as indicated on the Drawings and as described herein. The intent is to evenly load each chain & flight mechanism by placing two rows over each mechanism, and to utilize the existing column reinforcement such that all plate settler support columns shall be on 20-ft centers and all chain & flight supports shall be on 10-ft centers; all plate packs shall be full packs supported by beams on 20-ft centers. Place the edge of a plate pack row at the edge of a walkway (without any overlap) where centering the two rows over a mechanism would result in plates under a walkway; troughs may encroach under a walkway.

F. Weirs:
   1. Straight Weirs (when provided)
      a. Each trough shall be equipped with adjustable bolt-on flat-crested or straight weirs for leveling during initial installation and to provide an even flow distribution during operation.
      b. The weir shall be designed so each plate pack has a continuous weir for even flow distribution.
      c. The flat crested weirs shall be securely fastened by continuous pressure clamp. Provide weir locking mechanisms to lock the weir in place after leveling.
      d. Flat crested weirs shall be designed to set top deck flow depth to less than 2 inches.
      e. Adjustable weirs shall be gasketed with 1/8" thick EPDM or appropriately sealed with an NSF-61 compliant sealant.
   2. V-notch Weirs (when provided)
      a. Each trough shall be equipped with adjustable bolt-on v-notch weirs for leveling during initial installation and to provide an even flow distribution during operation.
      b. The v-notch weir shall be designed so each plate has two individual v-notches for even flow distribution.
      c. The v-notch weirs shall be securely bolted to the effluent troughs with 3/8" Type 316 SS through-bolt connection a minimum of every 12 inches.
      d. V-notch weirs shall operate at a minimum water elevation of 4 inches above the top flow control angle at design flow.
      e. Adjustable weirs shall be gasketed with 1/8" thick EPDM or appropriately sealed with an NSF-61 compliant sealant.

G. Responsibilities:
   1. Plate Settler Manufacturer is responsible for delivery of equipment and supplies required under these specifications.

a. Plate settlers shall be constructed of materials certified or classified by NSF or underwriters laboratories as meeting ANSI/NSF Standard 61.
b. Proper coordination and integration of all equipment required for supply in the basins, including plate pack assemblies, support beams and columns, and all other associated work shown on the drawings and specified in the Contract Documents.
c. Ensuring that the plate settler system shall be properly coordinated and will function as a unit in accordance with these specifications.
d. Ultimate responsibility for equipment coordination, operation, and guarantees.

2. The General Contractor (Contractor) will install the equipment. The Contractor will be responsible for:
   a. Proper coordination with Suppler and installation of all equipment in the basins including plate pack assemblies, support beams and columns, piping, and all other associated work shown on the drawings and specified in the Contract Documents
   b. Ultimate responsibility for equipment installation

2.03 PERFORMANCE REQUIREMENTS

A. The inclined plate settlers shall operate to meet the following performance conditions. In the event of noncompliance, the Inclined Plate Settler Manufacturer shall make all necessary adjustments, repairs and/or modifications necessary to meet the requirements before the Work will be accepted.
   1. Maximum Hydraulic Flow Rate per Sedimentation Basin = as specified above.
   2. Maximum Design Flow Rate per Sedimentation Basin = as specified above.
   3. Minimum Design Flow Rate per Sedimentation Basin = as specified above.
   4. Minimum Freeboard within Effluent Trough = 2 inches at design flow, based on the water surface elevation in the plate settler effluent trough assuming that the trough does not free discharge (downstream water surface elevation matches the water surface elevation in the trough).
   5. Minimum Headloss Induced by the Plate Settlers = 1.0 inches at design flow (measured from the weir elevation to the basin water surface upstream of and outside of the first plate pack).
   6. Maximum Headloss Induced by the Plate Settlers = 1.5 inches at design flow (measured from the weir elevation to the basin water surface upstream of and outside of the first plate pack).
   7. Maximum Flow Maldistribution along a Plate Pack Row = less than 10% (measured between the first and last plate pack in a given row of plate packs at design flow).
   8. Maximum Turbidity Maldistribution along a Plate Pack Row = less than 0.5 NTU difference (measured between the first and last plate pack in a given row of plate packs at design flow).
   9. Maximum acceptable daily average turbidity in the plate settler effluent trough shall be no greater than 1.0 NTU 95% of the time with influent turbidity at 1-10 NTU at design flow as measured over a 2-week test period and no greater than 2.0 NTU 95% of the time with influent turbidity at 11-100 NTU at design flow rate as measured over a 2-week test period.

2.04 GENERAL

A. All equipment shall be designed for continuous, 24-hour operation yet may be offline for extended periods, and exposed to the elements in a basin with no cover in a freezing climate. All parts of the product shall be proportioned for all stresses which may occur during fabrication, installation, operation, or standby.

B. Stainless steel nameplates giving the name of the manufacturer, model number, the rated capacity, shipping and operating weights, and any other pertinent data shall be attached to each unit.

C. The plate settler manufacturer shall coordinate the design and installation of the plate packs and support system with the chain & flight manufacturer.

D. Fabrication:
   1. All welding shall be performed by qualified personnel in strict accordance with manufacturer recommendations and in accordance with the latest requirements of AWS.
      a. Sharp corners of all cut or sheared edges shall be ground smooth where practical.
      b. Welds shall be rough ground to remove heavy weld ripple or unusual roughness per the latest recommended practices of AWS.
      c. Acceptable welding methods shall include MIG, TIG, stick-electrode, or as per the manufacturer's recommendations.
   2. All welds shall be fully cleaned and passivated after completion of welding operations in accordance with ASTM A380 standards. All pastes and solutions shall be disposed of in accordance with all applicable laws and regulations.

E. The components of the Inclined Plate Settlers shall be made from the following material:
   1. Plates: Type 304 SST (Type 304L SST if welded)
   2. Frames: Type 304L SST
   3. Top Flow Control Device: Type 304L SST
   4. Columns: Type 304 SST (Type 304L SST if welded)
   5. Beams: Type 304 SST (Type 304L SST if welded)
   6. Trough/Flume Assembly: Type 316 SST (Type 316L SST if welded)
   7. Stop-Plate Assembly: Aluminum Alloy 6061
   8. Baffles: Type: 316 SST (Type 316L SST if welded)
   9. Weirs: Type 316 SST (Type 316L SST if welded)
   10. Gaskets: EPDM Rubber
   11. Nuts, bolts, fasteners: 316 SST (in accordance with Section 05 50 20)

F. All components of the Inclined Plate Settlers that are not completely submerged under normal operation or at the air-water interface shall be constructed of Type 316 stainless steel (Type 316L SST if welded).

2.05 PLATE PACKS

A. Plate settler modules consisting of metal sheets stacked and assembled in a pack or module.

B. The channels shall have sufficient cross-sectional area, and shall be oriented on an angle of 55° from the horizontal, to promote gravity drainage of solids collected on the plate bottoms.

C. Plate settler modules shall fit in the corresponding sedimentation basin as indicated on the Drawings.

D. The plates shall be constructed with a uniform minimum thickness of 0.0250 inches (24 gauge) and shall have center stiffeners as needed to prevent deflection of plates. All surfaces shall be smooth to minimize the adherence of floc and algae growth. In addition:
   1. The plate shall be designed to handle a 30 lb. solids loading evenly distributed over the plate without failing, buckling, yielding, or creating a permanent deformation. The plate shall not exceed a maximum deflection of L/140 anywhere along the plate width and shall have center stiffeners as needed to prevent deflection of plates.
   2. The manufacturer shall provide a stamped report from a third-party testing laboratory in compliance with ASTM E330 and proving that the L/140 testing criteria is met.

E. Connectors
   1. Flexible connections shall be provided between each plate pack. Connectors shall be Neoprene sleeves with Type 304 stainless steel clamps.
   2. All gaskets and sleeves shall be neoprene.

2.06 EFFLUENT ASSEMBLY

A. The effluent assembly shall consist of side-mounted effluent troughs for each row of plate packs, and protected by perimeter aprons or separation walls that prevent the plates from becoming submerged at maximum hydraulic flow. Each trough shall be constructed with a minimum thickness of 0.0781 inches (14 gauge).
   1. Troughs shall be of the dual side-load arrangement, meaning one effluent trough per frame assembly shall not be allowed.
   2. The effluent trough shall be sized by Supplier. Flow into the trough will be controlled by continuous weirs.

B. The effluent trough shall be of continuous construction, or have a sealed connection, by use of SST and NSF 61 approved gaskets, between adjacent plate packs.
   1. All gaskets and sleeves shall be EPDM.

C. Minimum Number of Troughs and Minimum Trough Depth per Basin:
   1. Minimum Number of Troughs: As shown on the Drawings
   2. Minimum Trough Width and Depth:
      a. Between Plates: 30”(W) x 18”(D)
      b. Exterior to Plates: 16”(W) x 16”(D)

D. The effluent trough/ flume assembly shall be reinforced as necessary to handle the loads transmitted from the effluent trough to the effluent flume, and the loads due to maintenance activities. Lateral stiffness and rigidity shall be provided if necessary through the use of spreaders placed at strategic points along the length of the flume and fastened with Type 316 stainless steel hardware. To satisfy horizontal and vertical deflection requirements, angle stiffeners shall be used to reinforce the sides of the trough.

E. Troughs shall be designed for full backwash weight in empty basins without excessive deflections.

2.07 TOP FLOW CONTROL DEVICE

A. Each plate shall be equipped with an integral Type 304 stainless steel top flow control device (angle or perforated tube) to ensure that there is an even flow distribution across the entire surface area of the plate. The top flow control device shall visibly distribute flow across the width of the plate to engage the entire available settling area.

B. Top flow control device shall provide a suitable walking surface for routine cleaning and maintenance without the use of a temporary walking surface, such as plywood. No part of the plate settler system shall deform or fail due to walking on top of the plates.
   1. The manufacturer shall provide a P.E. stamped report from a third-party in compliance with ASCE 7-10 (Minimum Design Loads for Buildings and Other Structures) referencing catwalks for maintenance access. Specifically the flow control deck shall be designed using a minimum uniformly distributed live load of 40 psf and a minimum concentrated live load of 300 pounds. The top flow control device shall not experience any buckling, permanent deformation, or yielding.

2.08 ACCESSORIES

A. All support beams, support columns, brackets, fasteners, anchor bolts and similar items necessary to secure and support the furnished equipment in the tank shall be furnished by the equipment manufacturer and installed by the Contractor in accordance with the manufacturer's instructions.

B. Plate pack support beams shall be of the "concealed (hidden) beam" type, in which the bottoms of the beams are essentially flush with the bottoms of the plate packs.

C. The plate packs shall be supported by stainless steel structural members with a minimum material thickness of 5/16-inch.

D. Members supporting Evoqua's 4th axle (elevated tail shaft) shall have a minimum material thickness of 1/2-inch.

E. Support frames and beams shall be adequately sized to carry the load of the plate settling system under both wet and dry conditions without exceeding a maximum deflection of L/360 of the span.

F. Plate settler manufacturer shall equip one effluent trough per basin with a 1-inch stainless steel threaded nipple located below the water surface elevation within the

effluent trough for sampling purposes as indicated by the Drawings. The location of the nipple shall be at the end of the trough and shall be coordinated with the Engineer.

2.09 SURFACE FINISH/CLEANING

A. The plate pack structural frame welds shall be acid passivated after welding in accordance with ASTM A380 standards for corrosion resistance and to provide a superior surface finish. Passivation shall be done by electrochemically removing heat tint and discoloration by full dipping weldments; or by using an acid passivation paste in the weld and heat affected areas and spray-on acid solutions elsewhere, by the Manufacturer prior to being shipped. Testing to ensure proper passivation and cleaning has occurred shall be in accordance with Paragraph 7.2.5 of ASTM A380.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components, upon delivery, for shipping damage and conformance to specifications prior to installation. Repair or replace damaged items as directed by Construction Manager, including visible corrosion, at no additional cost to the Owner. Only factory-trained manufacturer's representative shall perform repair work.

3.02 INSTALLATION

A. Plate settler modules shall be provided in such configurations to minimize, if not eliminate, field modification; field welding shall not be allowed.

B. Contractor will install Supplier’s products in accordance with manufacturer’s instructions.
   1. In general, installation shall include:
      a. Install bolts, nuts, and washers at all mounting locations for each plate pack.
      b. Install shims under anchor plates where necessary to meet installation tolerances.
      c. Install flume connections to the collector trough and between plate packs.
      d. Install gaskets, bolts, nuts, and washers.
      e. Adjust weir plates to required elevation.
      f. Apply sealant around all gaskets after plate pack connections have been made and around all weir plates after elevations have been verified.
      g. Level plate pack supports with non-shrink, nonmetallic grout.
      h. Install and level the plate pack units and troughs in accordance with the Manufacturer's recommendations and the Drawings. All plate settler support anchor locations shall be leveled to within +/- 1/8 of an inch. Contractor shall exercise care in erecting and leveling the plate settlers, troughs, and weir plates so that the units are at the elevations shown on the Drawings or specified herein and have deflections within the manufacturer's specified limits.

C. After installation, all weirs shall be leveled to within 1/16 of an inch of target elevation as shown on the Manufacturer’s drawings. All brackets, fasteners, and similar items necessary to secure the furnished equipment in the basin shall be furnished by the Supplier.

3.03 FIELD TESTING

A. Contractor shall perform all testing under the supervision of the Supplier's representative. The Contractor shall conduct all specified tests and furnish all labor, equipment, materials, and supplies to conduct these tests. The Contractor shall be responsible for sample collection, shipping, and analyses of all test samples. The Contractor shall provide the Construction Manager with sufficient advance notice of the testing to enable the Supplier and Construction Manager to witness the tests.

B. Supplier shall provide the Contractor with protocols for all tests describing the type of test, test procedures, instrumentation used, proposed flow rates, and other information necessary to describe the proposed testing plan.

C. The effluent quality of the settled water tested at the effluent end of each trough must meet the performance requirements specified herein.

D. The inclined plate settlers shall demonstrate compliance with the specified hydraulic requirements. The inclined plate settlers shall be demonstrated to have the hydraulic capacity specified without maldistribution of flow or requiring more than the specified maximum headloss.

E. If a basin or individual plate pack assembly fails to meet specified performance requirements, the Supplier shall direct the Contractor to make necessary corrections and retest the settling basin or plate pack until the performance test is satisfactorily completed. No additional payments will be made for retesting.

F. Functional Testing
   1. Complete Functional Testing in accordance with Section 01 79 00.

G. Installation Tolerance:
   1. For the weirs on the plate pack trough, the maximum allowable variation shall be ±1/16-inch to achieve the water surface elevation indicated on the Drawings at maximum flow.

H. Tolerance shall be verified prior to filling with water. The Contractor shall provide equipment to verify tolerances. Operational Testing: As specified in Section 01 79 00.
   1. Upon completion of testing, the Supplier shall submit to the Construction Manager a copy of the completed test reports. Reports shall include description of the units tested, test procedures, test flow rates, pressures, levels, and all other data and results required to demonstrate that the equipment meets specified requirements.

3.04 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall coordinate field service work with the Manufacturer's representative, Owner, and Construction Manager prior to initiating such work.

B. The manufacturer shall provide a qualified field technician to perform the following:
   1. Inspect the system before initial start-up and verify that system has been correctly installed, as specified herein and in Section 01 79 00, prior to filling with water.

C. The Manufacturer shall provide the services of a factory field service technician or Engineer as follows:
   1. To include, but not limited to, four (4) trips to the site, totaling 20 days of on- site work. A day on-site shall be considered to be 8 hours in duration.
   2. Observe/advise the Contractor on the installation of the equipment.
   3. Check and verify that installation of the equipment is in accordance with the Drawings and Manufacturer's installation instructions.
   4. Should chemical dosing changes be required to meet performance requirements, Manufacturer shall recommend adjustments in coagulant chemical dosages.
   5. Assist in start-up and testing of the settler system as required.
   6. Instruct the Owner's personnel on operation and maintenance of the settlers. Personnel instruction shall consist of not less than one (1) day of classroom and field training. Subjects shall include the following:
      a. Troubleshooting.
      b. Operating adjustments for performance optimization.
      c. Preventive maintenance.
      d. Maintenance procedures.

3.05 MATERIAL ESCALATION

A. Method to adjust price based on stainless steel price fluctuations:
   1. The cost for stainless steel shall be adjusted at a time mutually agreed by Contractor and Owner after submittals have been approved. The Equipment Price shall be adjusted based on the fluctuation of stainless-steel surcharge plus base price. Price adjustment is based on confirmed stainless steel weight as provided by the equipment manufacturer. The base price fluctuations shall be validated by two domestic stainless-steel producers/mills. Price will be adjusted once for Milestones 3 and 4 (plate settler fabrication) material purchase. No escalation will occur for Milestones 1 and 2 (support system fabrication).
      a. The web addresses for the reference stainless steel surcharge prices is as follows:
         1) http://www.estainlesssteel.com/usstainlesssurcharges.shtml
         2) https://secure.outokumpu.com/steelfinder/as/americas.aspx
      b. Example = [(February 2023 surcharge price - June 2022 surcharge price) + (February 2023 base price - June 2022 base price)] * Total Weight
      c. The Contractor will not receive any markup on the price adjustment and will pass any price increase to the Supplier to compensate for the change in market conditions.
      d. The Contractor will not receive any markup on the price adjustment and will pass any price decrease to the Owner to compensate for the change in market conditions.
   2. The index adjustment shall only apply to stainless steel provided as part of the plate settler equipment package (excluding support system).

END OF SECTION