

BID DOCUMENTS FOR CONSTRUCTION OF  
GRANGE CREEK IRRIGATION PUMP STATION

FOR

CITY OF THORNTON, COLORADO

OCTOBER 2023



**SECTION 00 01 10 – TABLE OF CONTENTS**

**FOR  
GRANGE CREEK PUMP STATION  
FOR  
CITY OF THORNTON**

<b>Section</b>	<b>Person Responsible</b>	<b>Title</b>	<b>Page</b>
TECHNICAL SPECIFICATIONS			
Division 01 - General Requirements			
01 10 00	NLO	Summary of Work	1-6
01 22 20	NLO	Unit Price Measurement & Payment	1-9
01 33 00	NLO	Submittal Procedures	1-8
01 45 00	NLO	Quality Control	1-3
01 50 00	NLO	Temporary Facilities and Controls	1-7
01 56 39	NLO	Temporary Tree and Plant Protection	1-4
01 60 00	NLO	Product Requirements	1-2
01 70 00	NLO	Execution and Closeout Requirements	1-12
01 75 00	NLO	Testing, Training, and Commissioning	1-5
01 78 23	NLO	Operation and Maintenance Data	1-9
Division 02 - Existing Conditions			
02 30 00	NLO	Subsurface Investigation	1-1
02 41 00	NLO	Demolition	1-6
Division 03 – Concrete			
03 11 00	NLO	Concrete Work	1-32
Division 04 - Masonry			
04 20 00	RCE/LHM	Unit Masonry	1-8
Division 05 – Metals			
05 12 00	RCE	Structural Steel Framing	1-4
05 31 23	RCE	Steel Roof Decking	1-4
Division 06 - Wood and Plastics			
NOT USED			
Division 07 - Thermal and Moisture Protections			
07 19 00	LHM	Water Repellents	1-3
07 21 00	LHM	Thermal Insulation	1-2
07 41 13	LHM	Standing Seam Metal Roof Panels	1-8
07 62 00	LHM	Sheet Metal Flashing and Trim	1-7
07 72 00	LHM	Roof Accessories	1-3
07 92 00	LLA	Joint Sealants	1-7
Division 08 - Doors and Windows			
08 11 13	LHM	Hollow Metal Doors and Frames	1-6

08 71 00	LHM	Door Hardware	1-14
Division 09 - Finishes			
09 22 16	LHM	Non-Structural Metal Framing	1-6
09 91 20	LHM	Painting (Professional Line Products)	1-13
Division 10 - Specialties			
10 44 16	LHM	Fire Extinguisher	1-2
Division 11 - Equipment			
11 05 00	NLO	Common Work Results for Equipment	1-7
Division 12 - Furnishings NOT USED			
Division 13 - Special Construction NOT USED			
Division 21 – Fire Suppression NOT USED			
Division 22 - Plumbing NOT USED			
Division 23 – Heating, Ventilation, and Air Conditioning (HVAC) NOT USED			
Division 25 – Integrated Automation NOT USED			
Division 26 - Electrical			
26 00 00	BHEC	Basic Electrical Materials and Methods	1-19
26 29 23	BHEC	Variable Frequency Drives	1-4
Division 27 - Communications NOT USED			
Division 28 – Electronic Safety and Security NOT USED			
Division 31 - Earthwork			
31 05 13	NLO	Soils for Earthwork	1-5
31 10 00	NLO	Site Clearing	1-8
31 22 13	NLO	Rough Grading	1-5
31 23 16	NLO	Excavation	1-6
Division 32 - Exterior Improvements			
32 91 13	NLO	Soil Preparation	1-6
32 92 23	NLO	Sodding	1-5

Division 33 - Utilities  
33 13 00 NLO Testing of Water Utility Piping 1-5

Division 34 - Transportation  
NOT USED

Division 40 - Process Integration

40 05 13	NLO	Common Work Results for Process Piping	1-16
40 05 51	NLO	Common Requirements Results for Process Valves	1-6
40 05 51.15	NLO	Gate Valves	1-4
40 05 51.24	NLO	Check Valves	1-3
40 05 67.39	NLO	Pressure Relief Valves	1-4
40 05 78	NLO	Miscellaneous Valves	1-5
40 71 13	NLO	Magnetic Flow Meters	1-6
40 73 13	NLO	Pressure and Differential Pressure Gauges	1-5
40 90 00	BHEC	Instrumentation	1-10
40 95 00	BHEC	Programmable Logic Controller	1-6

Division 41 – Material Processing and Handling Equipment  
NOT USED

Division 43 – Process Gas & Liquid Handling

43 05 20	NLO	Common Work Results for Liquid Handling Equipment	1-11
43 21 00	NLO	Liquid Pumps	1-11
43 21 13	NLO	Centrifugal Liquid Pumps	1-4

DRAWINGS

See Sheet G-1 for Drawing Index

SUPPLEMENTARY INFORMATION

APPENDIX A – Proposed Pump Submittal

END OF SECTION



## SECTION 01 10 00 – SUMMARY OF WORK

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Work covered by Contract Documents
  2. Coordination of Drawings and Specifications
  3. Time of Completion/ Liquidated Damages
  4. Site access
  5. Site Investigation and Physical Data
  6. Work by Owners or Others
  7. Owner-Furnished Products
  8. Contractor's use of Site
  9. Permits
  10. Construction within Private Easements
  11. Traffic Control and Protection
  12. Materials and Compaction Testing
  13. Limits of the Work and Storage of Spoils
  14. Field Changes, Alignment, and Grade
  15. Testing and Operation of Facilities
  16. Protection of Existing Structures and Work
  17. Salvage and Debris
  18. Safety Standards and Accident Prevention
  19. Public Safety and Convenience
  20. Warranty Period
  21. Utility Properties and Service
  22. Sanitary Facilities
  23. Street Cleanup
  24. Record Drawings

- 25. "Or Equal" Clause
  - 26. Surveys
  - 27. Dust Prevention
  - 28. Erosion and Sedimentation Control
  - 29. Interferences, Obstructions, and Sewer Crossings
  - 30. Storage and Protection of Equipment and Materials
  - 31. Competent Person Designation
  - 32. Emergency Maintenance Supervisor
  - 33. Specification Conventions
  - 34. Use of Explosives
- 1.2 WORK COVERED BY CONTRACT DOCUMENTS
- A. Refer to City of Thornton Contract documents.
- 1.3 COORDINATION OF DRAWINGS AND SPECIFICATIONS
- A. Refer to City of Thornton Contract documents.
- 1.4 TIME OF COMPLETION/ LIQUIDATED DAMAGES
- A. Refer to City of Thornton Contract documents.
- 1.5 SITE ACCESS
- A. Refer to City of Thornton Contract documents.
- 1.6 SITE INVESTIGATION AND PHYSICAL DATA
- A. Refer to City of Thornton Contract documents.
- 1.7 WORK BY OWNER OR OTHERS
- A. Refer to City of Thornton Contract documents.
- 1.8 OWNER-FURNISHED PRODUCTS
- A. Owner's Responsibilities:
    - 1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples to Contractor.
    - 2. Arrange and pay for delivery to Site.
    - 3. Upon delivery, inspect products jointly with Contractor.

4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
  5. Arrange for Manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
  2. Receive and unload products at Site; inspect for completeness or damage jointly with Owner.
  3. Handle, store, install, and finish products.
  4. Repair or replace items damaged after receipt.
- C. Items furnished by Owner for installation by Contractor:
1. Goulds vertical turbine pump
  2. Programmable Logic Controller (PLC)
  3. Variable Frequency Drive (VFD)

#### 1.9 CONTRACTOR'S USE OF SITE

- A. Partial Owner Occupancy: Owner's Contractor may occupy the adjacent premises during portions of construction period. Coordinate with Owner during construction operations to minimize conflicts and facilitate construction work.
- B. Maintain access to existing sidewalks. Do not close or obstruct sidewalks without written permission from Owner and authorities having jurisdiction.
- C. Provide not less than 7-day notice to Owner of activities that will affect Owner's operations.
- D. All work shall be conducted between the hours of 7:00 a.m. and 6:00 p.m. on non-holiday weekdays only. No weekend work will be allowed. Requests for variations in work hours shall be made in writing for consideration by the Engineer. No work shall be conducted outside of the above-described days and hours without prior approval of the Engineer.

#### 1.10 PERMITS

- A. Refer to City of Thornton Contract documents.

#### 1.11 TRAFFIC CONTROL AND PROTECTION

- A. The CONTRACTOR shall maintain traffic control and protection in the work areas twenty-four (24) hours per day. Traffic control shall conform to the standards set forth in the "Federal Manual on Uniform Traffic Control Devices" (MUTCD) issued by the U.S. Department of Transportation and the Colorado Supplement to the MUTCD prepared by the Colorado Department of Transportation (CDOT) as well as respective local agency requirements.

- B. The CONTRACTOR shall conduct its operations to keep one lane of traffic open in each direction for public and private access at all times on City, County and Public streets, roads and highways, unless otherwise approved or required. If required by the State, the CONTRACTOR shall conduct its operations to keep both directions of traffic open on State Highways. Permits obtained for the project may have more stringent requirements than noted in this section.
- C. Prior to beginning construction, the CONTRACTOR shall submit a detailed traffic control plan to the City of Thornton Traffic Engineering for approval. Contractor shall include any planned trail closures and detours. As construction proceeds, the CONTRACTOR shall notify the ENGINEER as to the status of street closures and detours.
- D. All work shall be carried on with due regard for safety to the public. Open trenches shall be provided with barricades of a type that can be seen at a reasonable distance, and at night they shall be distinctly indicated by adequately placed lights.

#### 1.12 MATERIALS AND COMPACTION TESTING

- A. The CONTRACTOR shall provide the services of a licensed, independent agency to perform materials and compaction testing for this project. The agency must be approved by the OWNER. Materials and compaction tests will be required to show that specified densities of compacted backfill and asphaltic concrete surfacing are being achieved by the CONTRACTOR's compaction methods. The CONTRACTOR shall provide the OWNER and ENGINEER with copies of recent Proctor tests for the backfill and paving material in addition to copies of compaction tests performed in the field.
- B. After the OWNER is satisfied that the CONTRACTOR's method of compaction consistently meets specified compaction requirements, the testing frequency may be reduced at the discretion of the OWNER. The OWNER may direct testing at a higher frequency upon failure to obtain specified densities or if the CONTRACTOR changes compaction equipment or methods of compaction. The CONTRACTOR shall pay the cost of the Quality Control tests and any Quality Control re-tests that may be required, including all transportation charges. The OWNER shall pick the location and depths at which compaction tests shall be taken

#### 1.13 LIMITS OF THE WORK AND STORAGE OF SPOILS

- A. The limits of the site which may be used for construction, storage, materials handling, parking of vehicles and other operations related to the project include the project site as shown on the drawings and adjacent public rights-of-way subject to permission of the public owner of that right-of-way. The limits of work also include rights of access obtained by the CONTRACTOR, subject to all public laws and regulations and rights of access by utility companies and other holders of easement rights.

#### 1.14 FIELD CHANGES, ALIGNMENT, AND GRADE

- A. Refer to City of Thornton Contract documents.

#### 1.15 TESTING AND OPERATION OF FACILITIES

- A. Refer to City of Thornton Contract documents.

1.16 PROTECTION OF EXISTING STRUCTURES AND WORK

A. Refer to City of Thornton Contract documents.

1.17 SALVAGE AND DEBRIS

A. Unless otherwise indicated on the drawings or in the specifications, all castings, pipe, equipment, demolition debris, spoil or any other discarded material or equipment shall become the property of the CONTRACTOR and shall be disposed of in a manner compliant with applicable Federal, State, and local laws and regulations governing disposal of such waste products. No burning of debris or any other discarded material will be permitted.

1.18 SAFETY STANDARDS AND ACCIDENT PREVENTION

A. Refer to City of Thornton Contract documents.

1.19 PUBLIC SAFETY AND CONVENIENCE

A. Refer to City of Thornton Contract documents.

1.20 WARRANTY PERIOD

A. Refer to City of Thornton Contract documents.

1.21 UTILITY PROPERTIES AND SERVICE

A. Refer to City of Thornton Contract documents.

1.22 SANITARY FACILITIES

A. Refer to City of Thornton Contract documents.

1.23 STREET CLEANUP

A. Refer to City of Thornton Contract documents.

1.24 RECORD DRAWINGS

A. Refer to City of Thornton Contract documents.

1.25 "OR EQUAL" CLAUSE

A. Refer to City of Thornton Contract documents.

1.26 SURVEYS

A. Refer to City of Thornton Contract documents.

1.27 DUST PREVENTION

A. Refer to City of Thornton Contract documents.

1.28 EROSION AND SEDIMENTATION CONTROL

A. Refer to City of Thornton Contract documents.

1.29 INTERFERENCES, OBSTRUCTIONS, AND SEWER CROSSINGS

A. Refer to City of Thornton Contract documents.

1.30 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

A. Refer to City of Thornton Contract documents.

1.31 COMPETENT PERSON DESIGNATION

A. Refer to City of Thornton Contract documents.

1.32 EMERGENCY MAINTENANCE SUPERVISOR

A. Refer to City of Thornton Contract documents.

1.33 SPECIFICATION CONVENTIONS

A. Refer to City of Thornton Contract documents.

1.34 USE OF EXPLOSIVES

A. The use of explosives shall not be allowed on this Project. Alternative methods of excavation shall be utilized.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

## SECTION 01 22 20 - UNIT PRICE MEASUREMENT AND PAYMENT

### PART 1 GENERAL

#### 1.1 GENERAL

1. The total amount bid in the Bid Form shall cover all Work required by the Contract Documents. The prices bid shall include all costs associated with the proper and successful completion for the Work including, but not limited to: furnishing all materials, equipment, supplies and appurtenances; providing all construction equipment and tools; and, performing all necessary labor and supervision to fully complete the Work. All Work not specifically set forth as to the pay item or items listed in the Bid Form shall be considered subsidiary obligations of the CONTRACTOR and all costs in connection therewith shall be included in the prices bid.

#### 1.2 SECTION INCLUDES

1. Format and Data Required
2. Preparation of Application for Payment
3. Substantiating Data for Progress Payments
4. Submittal Procedure
5. Basis of Payment
6. Base Items

#### 1.3 RELATED SECTIONS

1. The following list of Related Sections is not all inclusive and is provided for convenience only.
  - A. General Contract and Special Conditions

#### 1.4 FORMAT AND DATA REQUIRED

1. Submit applications typed on Application for Payment and Certificate for Payment using the required form as indicated by the Owner.

## PART 2 BID ITEMS

1. Mobilization, Bonds, Insurance, and Demobilization:
  - A. Measurement: The amounts paid for mobilization in the contract progress payment will be based on the percent of the original contract amount that is earned from other contract items in accordance with the Special Conditions.
  - B. Payment: Payment for mobilization shall be on a lump sum basis. The lump sum price for this item includes, but is not limited to, all labor and equipment required for mobilization, demobilization, procurement of bonds, insurance, and any labor necessary to obtain the required permitting as stated in the specifications. Note, permit fees will be waived and shall not be included.
  
2. Erosion and Sediment Control:
  - A. Measurement: Measurement and payment for erosion and sediment control will be on a lump sum basis and paid as a percentage of work complete.
  - B. Payment: The lump sum contract price for this item includes, but is not limited to, furnishing all materials, labor, tools, and equipment necessary to install and maintain the temporary erosion control and sediment maintenance measures throughout the life of the project, in accordance with approved permits, and to remove the temporary erosion control devices when ordered by the Engineer. Erosion control measures shown on the Plans are not intended to represent all measures required on this project.
  
3. Construction Survey and Post Construction Survey for Elevation Certificate:
  - A. Measurement: Measurement and payment for construction survey will be on a lump sum basis and paid as a percentage of work complete.
  - B. Payment: The lump sum contract price for this item includes, but is not limited to, furnishing all materials, labor, tools, and equipment necessary to develop and make all detail surveys necessary for layout and construction including setting of control points as shown in the Drawings, setting exact component locations, working points, lines, and elevations. A post-construction survey with final grades and spot elevations as required for the floodplain elevation certificate shall not be paid for separately but shall be included under this line item.
  
4. Remove and Replace Concrete Path:



- A. Measurement: Measurement and payment for removing and replacing existing concrete sidewalk shall be made on a per square yard basis for the actual sidewalk to be removed and replaced.
  - B. Payment: The unit price for this item includes, but is not limited to, all associated costs, materials, labor, tools, and equipment necessary to remove and replace the existing concrete sidewalk in kind to the nearest joint from the disturbed area as shown in the drawings. All work necessary and incidental to the construction will not be measured and paid for separately but shall be included in the work.
5. Protect Existing Tree in Place:
- A. Measurement: The measurement and payment for this item will be on a per each basis.
  - B. Payment: The unit price for this item includes, but is not limited to, all labor and materials necessary to protect the existing tree, root system, and branches per the Plans and Specifications. Additional labor required to get around tree shall not be paid for separately, but shall be included in the work.
6. Remove and Replace Disturbed Irrigation System
- A. Measurement: Irrigation system will be measured on a lump sum basis.
  - B. Payment: The lump sum contract price for this item includes, but is not limited to labor, materials and equipment required to replace disturbed irrigation system. Material procurement, material supply, layout, inspections, excavation, backfill, existing equipment location, directional boring, pipe and wire sleeves, tree protection, pot-holing, pipe, fittings, sprinkler heads, valves, wiring, controller enclosures, backflow enclosure, drip irrigation materials, and incidentals necessary to complete the item and provide the coverage of the areas to be landscaped, wire, sleeves, backfill, compaction, surface restoration, testing, adjusting, inspections and as- built and controller chart preparation will not be paid for separately but shall be considered as a subsidiary obligation of the Contractor under the contract price for the irrigation system.
    - a. Payment for this item shall only include the replacement for the new irrigation system as shown on the Grange Creek Landscaping Improvements project. See specification attachments for more information.
7. Complete in Place Cut/Fill/Compact - Grading

- A. Measurement: Earthwork quantities will not be measured but shall be a single lump sum item. Exceptions will be made when field changes are ordered. Excavation shall include all types of soil, earth, or rock, and all debris, trash, rock, or other materials encountered which must be removed in order to allow construction to the lines and grades shown in the Plans.
- B. Payment: Includes all equipment, excavation, loading, transporting, stockpiling, disposing, hauling off, importing fill, re-transporting to fill locations (from locations of excavation or from on-site or off-site stockpiles), watering, compaction, testing, subgrade preparation, measuring of subgrade to bring within tolerances, backfilling, dust control, mud control, rough grading and fine grading. Payment will be made as work progresses.
  - a. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to the nearest City approved disposal site.
  - b. No payment will be made for any earthwork by the Contractor that is not shown on the grading Plans and/or beyond the limits of construction.

8. Drainage Swale

- A. Measurement: Earthwork quantities will not be measured but shall be a single lump sum item. Exceptions will be made when field changes are ordered. Excavation shall include all types of soil, earth, or rock, and all debris, trash, rock, or other materials encountered which must be removed in order to allow construction to the lines and grades shown in the Plans.
- B. Payment: Includes all equipment, excavation, loading, transporting, stockpiling, disposing, hauling off, importing fill, re-transporting to fill locations (from locations of excavation or from on-site or off-site stockpiles), watering, compaction, testing, subgrade preparation, measuring of subgrade to bring within tolerances, backfilling, dust control, mud control, rough grading and fine grading. Payment will be made as work progresses.
  - a. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to the nearest City approved disposal site.
  - b. No payment will be made for any earthwork by the Contractor that is not shown on the

9. Replace Disturbed Sod

- A. Measurement: Sodding will be measured on a per square foot basis.
- B. Payment: Includes all the Contractor's costs to complete the sodding in accordance with the Specifications.
  - a. Includes spreading soil amendments and fertilizers, discing, ripping, tilling, raking, fine grading, furnishing and installation of seed, sod and mulch materials, temporary protection by fencing or other means, watering and all other required maintenance until Final Acceptance of the work within the limits of construction.
  - b. Areas disturbed outside of the construction limits shall be seeded or sodded as directed by the Project Manager at the expense of the Contractor.

10. Demo Existing Foundation and Building

- A. Measurement: Measurement and payment for demolishing the existing foundation and building will be on a lump sum basis and paid as a percentage of work complete.
- B. Payment: The unit price for this item includes, but is not limited to, all associated costs, materials, labor, tools, and equipment necessary to remove and demolish the existing building, concrete slab, and light pole.
  - a. Cost shall not include the cost to remove and demolish any mechanical piping or equipment inside the building.
  - b. The labor and associated costs to protect the tree in place shall not be included in the payment, but shall be part of bid item 5, Protect Existing Tree in Place.

11. Furnish and Install New Foundation and Building

- A. Measurement: Measurement and payment for furnishing and installing new foundation and building will be on a lump sum basis and paid as a percentage of work complete.
- B. Payment: The unit price for this item includes, but is not limited to, all associated costs, materials, labor, tools, and equipment necessary to install a new pump station building per the Plans including, but not limited to: all masonry and grout, door and door hardware, building foundation, sub-grade compaction, and all other associated costs as noted in the plans and specifications.

- a. Price for all electrical and mechanical equipment shall not be included under the line item.

12. Remove Existing Mechanical and Electrical Equipment:

- A. Measurement: Measurement and payment for demolishing the existing mechanical and electrical equipment will be on a lump sum basis and paid as a percentage of work complete.
- B. Payment: The unit price for this item includes, but is not limited to, all associated costs, materials, labor, tools, and equipment necessary to remove and demolish the existing mechanical and electrical equipment inside the building, including but not limited to: removing pump skid, removing pressure tank, removing and salvaging pumps and motors, removing and salvaging antenna, and removing all electrical components.
  - a. Price shall include the cost to salvage and transport any equipment to the City as called out on plans.
  - b. Price shall include the cost to transport and properly dispose of equipment to be demolished as called out on plans.
  - c. Price to protect existing wet well in place shall be considered incidental to the work performed.

13. Pump Installation, Certified Performance Testing, and Field Vibration Testing:

- A. Measurement: Measurement and payment for pump installation, certified performance testing, and field vibration testing shall be on a lump sum basis and paid for as a percentage of work complete.
- B. Payment: The unit price for this item includes, but is not limited to, the installation of the pumps including the pump base and sole plate, start-up and field vibration testing performed by a certified technician, and all other associated costs as noted on plan and specifications.
  - a. Pumps shall be owner-furnished, Contractor installed. Any labor to coordinate the delivery of the pumps with the Owner shall be considered incidental to this work.

14. Furnish and Install New Mechanical Piping, Accessories, and Meter:

- A. Measurement: Measurement and payment to furnish and install new mechanical piping and meter shall be on a lump sum basis and paid for as a percentage of work complete.

- B. Payment: The lump sum price for this item includes, but is not limited to, all mechanical piping, valving, drainage piping, blow-off, equipment (including air release valve, pressure gauges, strainer, etc.), pipe supports, fittings, and all other associated costs as shown on the plans and specifications.

15. Connection to Existing Irrigation System:

- A. Measurement: Measurement and payment for rock excavation shall be made on a lump sum basis and paid for as a percentage of the work complete.
- B. Payment: The unit price for this item includes, but is not limited to, excavation, bedding, backfill, potholing, and all other associated costs required to tie the new pump station to the new irrigation system as shown on the plans and specifications.

16. Electrical System:

- A. Measurement: Measurement and payment for this line item shall be on a lump sum basis and paid for as a percentage of work completed.
- B. Payment: The lump sum price for this item includes, but is not limited to, all labor, material, and associated costs to install the electrical equipment, unit heater, and exhaust fan as shown on the plans and specifications. Price to furnish and install all lighting, heating, and HVAC shall be included in the cost for this work.
  - a. Work, material, and labor required to connect the new transformer to the new building shall be included under the line item.

17. Instrumentation & Controls Work:

- A. Measurement: Measurement and payment for this line item shall be made on a lump sum basis and paid for as a percentage of work completed.
- B. Payment: The lump sum price for this item includes, but is not limited to, all instrumentation and control work as required in the Plans and specifications.

END OF SECTION

## SECTION 01 33 00 - SUBMITTAL PROCEDURES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section contains administrative and procedural requirements for submittals for review, information, and for Project closeout.
- B. Section includes:
  - 1. Submittal procedures.
  - 2. Shop Drawings.
  - 3. Samples.
  - 4. Design data.
  - 5. Test reports.
  - 6. Certificates.
  - 7. Manufacturer's instructions.
  - 8. Manufacturer's field reports.
  - 9. Construction progress schedules.
  - 10. Breakdown of contract price.
  - 11. Construction photographs.
  - 12. Operation and maintenance (O&M) instructions.

#### 1.2 SUBMITTAL PROCEDURES

- A. Contractor shall submit Shop Drawings and Samples to Engineer for review in accordance with the Owner and Contractor contractual agreement.
- B. All Contractor resubmittals shall be in accordance with the Owner and Contractor contractual agreement.

## PART 2 PRODUCTS

### 2.1 CONSTRUCTION PROGRESS SCHEDULES

- A. Within 10 days after the Effective Date of the Contract, prepare and submit to the Engineer a practicable schedule showing the order in which the Contractor proposes to carry out the Work, the dates on which the important features of the work will start, and the contemplated dates for completing same. A time-scaled bar chart schedule shall include the following:
  - Construction activities
  - Submittal and review of critical material samples and shop drawings
  - Procurement and delivery of critical materials
  - Duration of work, including completion times of all stages and their sub-phases
- B. Attention is drawn to typical local climatic weather patterns and Work shall be coordinated accordingly.
- C. Complete Project schedule shall be revised and resubmitted to the Engineer at a minimum occurrence of every three (3) weeks for review.
- D. Three Week Lookahead Schedules: Provide each week at the weekly construction meeting. The previous week's completed work shall be shown on the schedule for a total of 4 weeks shown.

### 2.2 BREAKDOWN OF CONTRACT PRICE

- A. Within 10 days after the Effective Date of the Contract, submit a complete breakdown of all lump sum bid items showing the value assigned to each part of the work, including an allowance for profit and overhead adding up to the total lump sum contract price.
- B. Breakdown of lump sum bids shall be coordinated with the items in the schedule and shall be in sufficient detail to serve as the basis for progress payments during construction.
- C. Engineer will review the contract price breakdown and may request items to be further broken down or for more items be added in order to facilitate tracking of work progress for payment.
- D. Preparatory work, bonds, and insurance required in setting up the job will be allowed as a separate entry on the cost breakdown but shall not exceed 5 percent of the total base bid.
- E. Upon acceptance of the breakdown of the contract price by the Engineer, it shall be used as the basis for all requests for payment.

## 2.3 PRODUCT DATA

- A. Product Data: Action Submittal: Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents. Submitted data shall be sufficient in detail for determination of compliance with the Contract Documents.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement Manufacturers' standard data to provide information specific to this Project.
  - 1. Note submittal will be returned to Contractor without review of submittal if products, models, options, and other data are not clearly marked or identified.
- C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- D. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

## 2.4 SHOP DRAWINGS

- A. Shop Drawings: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer licensed in the state of Project, responsible for designing components shown on Shop Drawings.
  - 1. Include signed and sealed calculations to support design.
  - 2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
  - 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- D. All dimensioned shop drawings shall be scalable and provided as full-sized (22-inch x 34-inch) sheets. PDF electronic files shall print as scalable full-sized sheets.
- E. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.



## 2.5 SAMPLES

- A. Samples: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Samples for Selection as Specified in Product Sections:
  - 1. Submit to Engineer for aesthetic, color, and finish selection.
  - 2. Submit Samples of finishes, textures, and patterns for Owner selection.
- C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.
- D. Include identification on each Sample, with full Project information.
- E. Submit number of Samples specified in individual Specification Sections; Engineer will retain one Sample.
- F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.
- G. After review, produce copies and distribute according to Paragraph 1.5.M and for record documents.

## 2.6 DESIGN DATA

- A. Informational Submittal: Submit data for Engineer's knowledge as Contract administrator or for Owner.
- B. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

## 2.7 TEST REPORTS

- A. Informational Submittal: Submit reports for Engineer's knowledge and records as Contract administrator or for Owner.
- B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

## 2.8 CERTIFICATES

- A. Informational Submittal: Submit certification by Manufacturer, installation/application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.

- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.

## 2.9 MANUFACTURER'S INSTRUCTIONS

- A. Informational Submittal: Submit Manufacturer's installation instructions for Engineer's knowledge as Contract administrator or for Owner.
- B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Engineer in quantities specified for Product Data.
- C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

## 2.10 MANUFACTURER'S FIELD REPORTS

- A. Informational Submittal: Submit reports for Engineer's knowledge and records as Contract administrator or for Owner.
- B. Submit report within 48 hours of observation to Engineer for information.
- C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

## 2.11 PROJECT HEALTH AND SAFETY PROGRAM

- A. Develop, publish, and implement an overall Project Health and Safety Program for the Project. This Program shall conform to all applicable codes. The written Safety Program shall be provided within 30 days after the receipt of the written Notice to Proceed. The Plan shall be assembled to address project specific health and safety issues to both the public and on-site personnel. The plan shall include at a minimum the following items when they apply:
  - 1. Employee orientation
  - 2. Safety inspections
  - 3. Instruction and training
  - 4. Accident reporting
  - 5. Signs and barricades
  - 6. Fire prevention and protection

7. Welding, cutting, and burning
  8. Painting and surface treatment
  9. Electricity
  10. Machinery and mechanized equipment
  11. Excavations
  12. Sanitation
  13. Chlorine safety
  14. Hazardous materials
  15. Hazardous communications program
  16. Job hazard analysis
  17. First aid/medical facilities
  18. Personal protective equipment
  19. Confined space entry plan
  20. Shoring plan
  21. Fall protection plan
  22. Emergency Action Plan
  23. Housekeeping
  24. Safety training requirements and certification
  25. Pedestrian access around work site during construction and after hours
  26. Neighboring residences/community access and safety
- B. If the Project requires other health and safety issues to be addressed, they too shall be included in the Project Health and Safety Program. The Program shall subsequently be distributed to and implemented by the Contractor's personnel, as well as its Subcontractors and Suppliers, the Owner and Engineer. Contractor shall fully implement and comply with the Safety Program and shall submit to the Owner a letter signed by Contractor's owner/president affirming such implementation and compliance within 15 days after on-site work has started. Contractor shall notify the

Owner and Engineer when safety meetings will be held so that Owner's and Engineer's personnel may attend. A copy of the Health and Safety Program must be maintained on-site at all times during the life of the Project.

## 2.12 CONSTRUCTION PHOTOGRAPHS

- A. Provide photographs of Site and construction throughout progress of Work produced by an experienced photographer acceptable to Engineer.
- B. Each month submit photographs with Application for Payment.
- C. Photographs: Electronic, PDF, or JPEG format.
- D. Take site photographs from different directions indicating relative progress of the Work, five (5) days maximum before submitting.
- E. Identify each photo in the electronic file name. Identify name of Project, phase, orientation of view, date, and time of view.
- F. Digital Images: Deliver complete set of digital image electronic files on CD-ROM to Owner with Project record documents. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as sensor, uncropped.
  - 1. Digital Images: Uncompressed TIFF format, produced by digital camera with minimum sensor size of 4.0 megapixels, and image resolution of not less than 1600 by 1200 pixels.
  - 2. Date and Time: Include date and time in filename for each image.

## 2.13 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

- A. Submit preliminary O&M materials for review by Engineer. The Equipment Manufacturer may furnish instruction manuals prepared specifically for the equipment furnished or standard manuals may be used if statements like "if your equipment has this accessory..." or listings of equipment not furnished are eliminated. O&M materials will be returned to the Contractor for resubmittal if the O&M materials do not clearly indicate what specific equipment was furnished and all items not provided being clearly crossed out. Poorly reproduced copies are not acceptable. Operation and maintenance instructions shall contain the following as a minimum:
  - 1. Reviewed shop drawings and submittal data;
  - 2. Model, type, size, and serial numbers of equipment furnished;
  - 3. Equipment and driver nameplate data;

4. List of parts showing replacement numbers;
  5. Recommended list of spare parts;
  6. Complete operating instructions including start-up, shutdown, adjustments, cleaning, etc.;
  7. Maintenance and repair requirements including frequency and detailed instructions; and
  8. Name, address and phone numbers of local representative and authorized repair service.
- B. Following review of the preliminary O&M materials by the Engineer and before acceptance of the Work, submit four copies of complete final operation and maintenance instructions for all equipment supplied. Submit items in 8-1/2 x 11-inch heavy-duty three-ring binders when appropriate, or in 8-1/2 x 11-inch file folders. All binders and folders shall have clear plastic pockets on the front of the cover and the spine to allow for insertion of identifying information.

#### 2.14 OTHER REQUIRED SUBMITTALS

- A. Other required submittals include the items listed below. This list is provided for Contractor's convenience only and may not be complete in all respects. Contractor shall provide all submittals specified or required, whether or not listed here.
1. Contractor Emergency Contact List.
  2. Erosion and Sediment Control Plan.

PART 3 EXECUTION - Not Used

END OF SECTION

## SECTION 01 45 00 - QUALITY CONTROL

### PART 1 GENERAL

#### 1.1 DESCRIPTION

- A. This Section covers quality control requirements supplementary to those of the General Conditions and Technical Specifications.

#### 1.2 PROVISIONS

- A. Contractor's Responsibility for Testing

The Contractor shall be responsible for the cost of all testing as specified in this section. Additional information has been provided regarding the payment responsibility for the Owner with regards to the Project.

- B. Owner's Right to Perform Additional Tests

The Owner or Engineer reserves the right to complete additional testing. In such cases, the Contractor shall provide safe access for the Owner or Engineer and their inspectors to adequately inspect the quality of work and the conformance with Project specifications.

#### 1.3 QUALITY ASSURANCE

- A. Testing Requirements

An independently owned and operated laboratory approved by the Engineer shall perform all testing as specified herein.

- B. Testing

##### 1. General

- a. All required testing of work and/or materials shall be conducted in the presence of the Engineer. The Contractor shall provide 48-hour notification to the Owner and Owner's representative prior to conducting any and all quality assurance testing. Where applicable, work and materials shall only be buried with the consent of the Engineer.
- b. Where such inspection and testing are to be conducted by an independent laboratory or agency, the sample, or samples of material to be tested shall be selected by such laboratory or agency or by the Engineer. The Contractor shall furnish such samples of all materials without charge to Owner.

- c. The results from any and all tests are made for the information of the Owner. Regardless of any test results, the Contractor is solely responsible for the quality of workmanship and materials and for compliance with the requirements of the Drawings and Specifications.

2. Costs of Testing

- a. The Contractor shall be responsible for and shall pay for all tests as specified in Part 3 of this Section. Additional information has been provided regarding the payment responsibility for the Owner with regards to the Project.
- b. With regards to all materials to be tested, where test results demonstrate that the material or workmanship does not meet the minimum requirements of the Contract Documents, additional testing shall be completed and shall be paid for by the Contractor with no reimbursement by the Owner.

1.4 SUBMITTALS

A. Laboratory Test or Inspection Reports

Each report shall be signed and certified by the independently owned and operated testing laboratory. Unless otherwise specified, submit three copies of each report to the Owner or Owner’s Representative.

PART 2 PRODUCTS – (Not Used)

PART 3 EXECUTION

3.1 FIELD TESTING SCHEDULE

- A. The Contractor shall complete field testing in accordance with the following schedule. Additional source material testing shall be completed as necessary to establish the basis of field tests. The frequency of testing listed in this schedule lists the minimum number of tests per quantity of work completed by the Contractor. Testing locations to be determined by the Engineer.

Material to be Tested	Payment Responsibility for Initial Testing	Minimum Testing Frequency
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Trench Backfill	CONTRACTOR	In-place compaction testing (w/ nuclear compaction gage), one test per 200 lineal feet of pipeline trench as measured along pipe centerline. Tests shall be taken at depths below finished subgrade ranging from one (1) foot above the top of the squeeze to one (1) foot below grade at an interval not exceeding two (2) feet. See Article 3.16, Field Quality Control of Section 31 23 17, Trenching for further details.
Concrete	CONTRACTOR	For each day of production or 1,000 square yards placed, aggregate samples shall be obtained for gradation. Slump, air content, unit weight and mix temperature shall be tested three (3) times for every 1,000 square yards of pavement placed. Four (4) compressive strength cylinders shall be cast for each 50 cubic yards or for each day of pour placed. See detailed requirements in Article 3.12, Concrete Tests of Section 03 30 00, Cast-In-Place Concrete.
Grout	CONTRACTOR	Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as specified in the City of Thornton Standards & Specifications to insure continued compliance with Specifications. See detailed requirements in Article 3.2, Field Quality Control of Section 03 60 00, Grouting.
Waterline – Hydrostatic testing	CONTRACTOR	As required. See Section 33 13 00, Testing of Water Utility Piping.

END OF SECTION



## SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Temporary construction facilities and control requirements for the Work include the following. Contractor responsible for providing all other temporary facilities and controls necessary to complete the Work as described in the Contract Documents.
  - 1. Utilities including lighting and electricity, heat, telephone service, internet access and water.
  - 2. Sanitary facilities.
  - 3. Fire protection.
  - 4. Contractor Work Area.
  - 5. Security.
  - 6. Barriers.
  - 7. Temporary Fencing.
  - 8. Progress Cleaning.
  - 9. Parking.
  - 10. Traffic Control.
- B. Maintain temporary facilities in proper and safe condition throughout progress of Work.
- C. Comply with federal, state, and local codes and regulations, and utility company requirements.

#### 1.2 LAYOUT OF TEMPORARY FACILITIES

- A. Before starting Work, submit to Owner, for approval, proposed layout of temporary facilities.
- B. Should Contractor require space in addition to that shown on Drawings, Contractor shall make arrangements for storage of materials and equipment in locations off Site.

1.3 UTILITY PROPERTIES AND SERVICE

- A. In areas where the Contractor’s operations are adjacent to or near a utility and such operations may cause damage which might result in significant expense, loss and inconvenience, the operations shall be suspended until all arrangements necessary for the protection thereof have been made by the Contractor.
- B. The Contractor shall notify all utility offices which may be affected by the construction operation at least 48 hours in advance. Before exposing any utility, the utility having jurisdiction shall grant permission and may oversee the operation. Should service of any utility be interrupted due to the Contractor’s operation, the proper authority shall be notified immediately. It is of the utmost importance that the Contractor cooperates with the said authority in restoring the service as promptly as possible. Any costs shall be borne by the Contractor.
- C. Contractor to contact one-number locator service (811) at least 48 hours in advance in advance of all excavations or other activities that may disturb and/or damage existing utilities. Existing utilities which may be impacted include the following:

Potable Water, Storm Drain	City of Thornton
Power	Xcel

1.4 TEMPORARY LIGHTING AND ELECTRICITY

- A. General:
  - 1. Temporary lighting shall be sufficient to enable Contractor and Subcontractors to complete Work and enable Owner to observe Work. Illumination shall meet or exceed state code requirements.
- B. Temporary electric power may be obtained from Owner’s electrical system as follows:
  - 1. Power is available at the site but may be limited. Power is available within existing structures but maybe significantly limited due to existing equipment and loads.
- C. Temporary Electric Power:
  - 1. Provide, maintain, and remove temporary electric service facilities.
  - 2. Provide temporary electric systems and components in conformance with requirements of National Electric Code and local authorities.

3. Facilities exposed to weather shall be weatherproof type.
4. Enclosures shall be locked to prevent unauthorized access.
5. Provide lamps, wiring, switches, sockets, and similar equipment required for temporary lighting and power tools.
6. Provide electric service to temporary offices.

#### 1.5 TEMPORARY HEAT

##### A. General:

1. Provide heating required for cold weather protection for all facilities.
2. Provide heating required after enclosure of structure.
3. Except as otherwise called for, temperature shall be kept above 50°F.
4. Heat shall be warm air from oil, electric or gas-fired portable heaters suitably vented to outside.
5. Open salamander type heaters are not permitted.

##### B. Temporary Heating:

1. Provide temporary heat, pay fuel costs, and maintain heating units.
2. Provide adequate heat to all parts of structure.
3. Repair or replace materials damaged because of lack of heat.
4. Provide throwaway filters if permanent system used for temporary heat.
5. If permanent system is used for temporary heat during construction, all system components shall be cleaned at completion of work, including ductwork.

#### 1.6 TEMPORARY COMMUNICATIONS

- A. Provide temporary telephone service for Contractor's use. Cell phones are acceptable but a source for local sending/receiving of fax transmission is required.

#### 1.7 WATER FOR CONSTRUCTION AND TESTING

- A. Contractor is responsible for obtaining a temporary water meter from the City and paying the applicable deposit cost.

1. Non-potable water for construction purposes will be furnished by the Owner at no cost.
2. The Contractor shall furnish all valves, hoses, connections, and other devices as necessary to obtain sufficient water for construction and for filling and testing of water lines as required. Fire hydrant use is allowed only by permission of the utility owner.
3. Backflow protection is required on all connections to potable water systems.

#### 1.8 SANITARY FACILITIES

- A. Provide temporary sanitary facilities conforming to state and local regulations, in sufficient numbers for use of Contractor's and Subcontractor's employees.
- B. Maintain in sanitary condition and properly supply with toilet paper.
- C. Use of the City's existing sanitary facilities is not allowed.

#### 1.9 TEMPORARY FIRE PROTECTION

- A. Provide and maintain fire extinguishers and other fire protection equipment and devices as would be reasonably effective in extinguishing fires during early stages by personnel at Site.

#### 1.10 TEMPORARY SITE AND OTHER ROADS

- A. Maintain existing roads used during construction free from accumulation of dirt, mud, and construction debris.
- B. Contractor shall repair or replace existing roads that remain to original or better condition prior to Final Completion. Survey and record condition of existing roads prior to construction.

#### 1.11 CONTRACTOR'S WORK AREA

- A. Work Area:
  1. Limit construction operations and storage of equipment and materials to areas shown on Drawings and as determined by Owner.
  2. Except as provided herein, no private property, or other area adjacent to Site shall be used for storage of Contractor's equipment and materials unless prior written approval is obtained from legal owner of the respective locations.
  3. Contractor shall maintain staging areas during construction in a manner that will not obstruct operations of existing facilities. Work shall proceed in an orderly

manner, maintaining construction Site and staging area free of debris and unnecessary equipment or materials.

B. Storage and Protection of Equipment and Materials:

1. The Contractor shall be solely responsible for the protection and security of all equipment and materials stored on the site. Equipment and materials stored at the site shall be placed neatly on the job site in an area and environment that will provide protection and security. Materials that are not adequately protected or stored in conformance with the Manufacturer's recommendations will be rejected. Unusable materials (i.e., rejected, or damaged liner material, old concrete chunks, metal scraps, etc.) shall be expeditiously removed from the job site.
2. Provide appropriate barricades, signs, and traffic control devices in like-new condition where necessary to protect the public and City employees from any hazards associated with the storage of materials and equipment used for this Project.
3. No equipment and/or materials shall be stored outside the immediate work area, in the following locations, or in the following manner:
  - a. In any maintained landscaped or lawn area.
  - b. In a manner that would totally eliminate an individual residents' street parking, or parking for the City's existing buildings.
  - c. In front of any business.
4. The "immediate work area" is the area where work is taking place or will be taking place within one calendar day. The Contractor shall immediately move stored material or equipment which causes a nuisance or creates complaints

#### 1.12 SECURITY

- A. Contractor shall be responsible for loss or injury to persons or property where Work is involved and shall provide security and take precautionary measures to protect Contractor's and Owner's interests.
- B. Provide and maintain temporary fencing of design and type needed to prevent entry into active construction areas.

#### 1.13 TEMPORARY FENCING

- A. Construction: Commercial grade chain link fence

- B. Provide 6 foot high fence around construction site; equip with vehicular gates with locks
- C. Provide additional fencing to protect stored materials and products or to ensure public safety and the safety of Owner's employees

#### 1.14 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition
- B. Remove debris and rubbish from remote spaces prior to enclosing the space
- C. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in accordance with local and state regulations
- D. At a minimum, the site and areas of work are to be cleaned on a weekly basis
- E. Sweep, vacuum and clean interior areas prior to start of surface finishing

#### 1.15 PARKING

- A. Staging area and designated areas within construction limits may be used for parking of construction personnel's private vehicles and Contractor's lightweight vehicles.
- B. Make arrangements for additional parking off site as required.
- C. No overnight parking, camping, or storage of personal vehicles, trailers or other personal items will be authorized.

#### 1.16 TRAFFIC CONTROL AND PROTECTION

- A. The Contractor shall maintain traffic control and protection in the work areas 24 hours per day. Traffic control shall conform to the requirements set forth by the Colorado Department of Transportation as well as the standards set forth in the Manual on Uniform Traffic Control Devices (MUTCD) and local jurisdiction.
- B. The Contractor shall conduct its operations so as to keep one lane of traffic open for public and private access at all times on City, County and Public streets, roads and highways. Permits obtained for the Project may have more stringent requirements than noted in this section.
- C. Prior to beginning construction and as necessary or required by local or state agencies, the Contractor shall submit a detailed street closure and traffic control plan to the Owner for approval, which meets the requirements of the of the Colorado Department

of Transportation. As construction proceeds, the Contractor shall notify the Owner as to the status of street closures and detours, if required.

- D. All work shall be carried on with due regard for safety to the public. Open trenches shall be backfilled or covered with steel plates at the end of each day.

PART 2 PRODUCTS- (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. Maintain and operate systems to ensure continuous service for duration of construction.
- B. Modify and extend systems, as Work progress requires.

3.2 REMOVAL

- A. Completely remove temporary materials, equipment, signs, and structures when no longer required.
- B. In unfinished areas, clean and repair damaged caused by temporary installations or use of temporary facilities, restore drainage, and evenly grade, seed, or plant as necessary to provide appearance equal to or better than original.
- C. In finished areas, restore existing or permanent facilities used for temporary services to specified, or original condition.

3.3 DAMAGE TO EXISTING PROPERTY

- A. Contractor is responsible for replacing or repairing damage to existing buildings, structures, sidewalks, roads, parking areas, and other existing assets.
- B. Contractor shall have option of having Owner contract for such Work and have cost deducted from Contract Price.

END OF SECTION

## SECTION 01 56 39 - TEMPORARY TREE AND PLANT PROTECTION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes provisions for temporary protection of trees and other plant life in preparation for site or building excavation Work.
- B. This specification shall be applied concurrently and in conjunction with other plant material protection measures herein described and specified.
- C. Related Sections:
  - 1. Section 31 10 00 - Site Clearing
  - 2. Section 31 22 13 - Rough Grading
  - 3. Section 31 23 16 - Excavation
  - 4. Section 31 23 17 - Trenching

### PART 2 MATERIALS - Not Used

### PART 3 EXECUTION

#### 3.1 INSPECTION

- A. Inspect all trees specified on the Drawings for protection prior to construction.
  - 1. Document with written memorandum and photographs any unusual conditions.
  - 2. Submit copies of documentation and photographs of existing trees to remain to Engineer prior to beginning work.
- B. Verify all conditions on the Drawings with actual conditions at Site regarding tree protection prior to any site disturbance.
- C. The Engineer must be present during demolition of existing conditions occurring within the drip line of trees designated to remain.
- D. Notify Engineer 24 hours prior to inspections and/or tagging of protected trees.

#### 3.2 PROTECTION

- A. Install barricades specified in the Drawings at drip lines of trees designated to remain prior to the commencement of construction.
- B. Clearly designate protected trees and clear of any material storage, personnel, or vehicular movement.



- C. Provide temporary fencing, barricades, and guards as necessary or required to protect trees designated on the Drawings to remain, from damage above and below grade.
- D. Protect root systems of trees and plant life to remain.
  - 1. Protect from damage due to noxious materials in solution caused by runoff or spillage during mixing and placement of construction materials.
  - 2. Protect from flooding, erosion, or excessive wetting resulting from dewatering operations and compaction.
  - 3. Protect against unauthorized cutting, breaking, skinning roots and branches, or bruising bark.
  - 4. Protect from smothering and compaction.
    - a. Do not store construction materials or permit vehicles to drive or park within the drip line area of any tree to remain.
  - 5. Protect from dumping of refuse in close proximity.
- E. Where cutting is necessary, review conditions with the Engineer before proceeding, and comply with directives of Engineer.

### 3.3 EXCAVATION AROUND TREES

- A. Excavate within drip lines of trees only where indicated on the Drawings or as directed by Engineer.
- B. Where trenching for utilities is required within drip lines, tunnel under or around roots by hand excavating.
  - 1. Where possible trench toward trunk of tree and tunnel under central root mass to avoid severing all lateral roots on side of trench.
  - 2. Do not cut main lateral roots or tap roots over 1-inch in diameter.
  - 3. Temporarily support and protect trees from damage until permanently covered with approved backfill.
- C. Do not allow exposed roots to dry out before backfill is placed.
  - 1. Provide temporary earth or burlap cover.
  - 2. Water roots daily when exposed and maintain in a moist condition.
- D. Backfill roots only upon inspection approval from the Engineer.
  - 1. Backfill around root excavations only with clean imported topsoil free from materials deleterious to root growth.
  - 2. Backfill to eliminate voids and compact only by means of manual tamping at root areas.

3. Water sufficiently to settle topsoil and eliminate voids or air pockets around roots.
  4. Allow for natural settlement of soil surface and furnish and apply topsoil sufficient to bring to original finish grade after backfill settlement.
- E. If during excavation, any condition arises that threatens the survivability of the protected tree, or an unknown condition arises that affects the stability or integrity of the root system, notify the Engineer immediately.

#### 3.4 REPAIR AND REPLACEMENT OF DAMAGED TREES

- A. In the event of damage to existing trees:
1. Immediately prune limbs smaller than 3-inch caliper or roots smaller than 2-inch caliper to repair trees damaged by construction operations.
  2. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
  3. Any such pruning and/or repairs shall be approved in advance and at completion by Engineer.
  4. The Engineer shall reserve the right, at cost to the Contractor, to obtain the services of a Certified Consulting Arborist with current membership in the American Society of Consulting Arborists to determine the severity of damage.
  5. The Contractor is responsible for the cost of repairs caused by their actions or by the actions of subcontractors engaged by the Contractor.
- B. Remove and replace dead or damaged trees which are determined by the Engineer to be incapable of restoration to normal growth patterns at no additional cost to Owner.
1. Provide new trees of the same species as those removed or damaged, with size and/or quantity to be determined by Engineer.
  2. Furnish replacement trees and plant life to the Site and plant, maintain, and warranty as directed by the Engineer.
  3. If trees are not replaceable with the same species, and size, compensate the Owner for the replacement cost of the trees based on the evaluation of a Certified Consulting Arborist.
  4. The Contractor is responsible for additional costs of removing damaged trees and labor for planting new specimens.

#### 3.5 DESIGNATED TREE REMOVAL PROCEDURES

- A. If designated tree removal is specified by Engineer, furnish labor, material, and equipment necessary for removing and/or salvaging existing trees, if necessary, as designated on the Drawings for removal.
1. Verify location and species with Engineer prior to removal.

- B. Salable logs or timber may be sold to Contractor's benefit upon notification and prior approval of Owner. Upon approval, remove salable logs or timber promptly from site.

3.6 GRADING AND FILLING AROUND TREES

- A. Maintain existing grade within drip line of trees unless otherwise indicated on the Drawings or directed by the Engineer.

3.7 MAINTENANCE OF PROTECTIVE MEASURES

- A. Maintain protective measures throughout the construction process. Immediately repair any alteration to protection measures throughout construction process. Repair or reinstall protective measures immediately upon alteration. Monitor protective measures daily.
- B. Remove and clear area of debris and fencing, barricades, etc., upon final written approval of Engineer.

END OF SECTION

## SECTION 01 60 00 - PRODUCT REQUIREMENTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.

#### 1.2 PRODUCTS

- A. At minimum, comply with specified requirements and reference standards.
- B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.
- C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that Manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.

#### 1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products according to Manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.

#### 1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products according to Manufacturer's instructions.
- B. Store products with seals and labels intact and legible.
- C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.
- D. For exterior storage of fabricated products, place products on sloped supports aboveground.
- E. Provide off-Site storage and protection when Site does not permit on-Site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

- H. Provide equipment and personnel to store products; use methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

## SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Field engineering.
- B. Closeout procedures.
- C. Starting of systems.
- D. Demonstration and instructions.
- E. Testing, adjusting, and balancing.
- F. Project record documents.
- G. Operation and maintenance data.
- H. Manual for materials and finishes.
- I. Manual for equipment and systems.
- J. Spare parts and maintenance products.
- K. Product warranties and product bonds.
- L. Maintenance service.
- M. Examination.
- N. Preparation.
- O. Execution.
- P. Protecting installed construction.
- Q. Final cleaning.

#### 1.2 FIELD ENGINEERING

- A. Employ land surveyor registered in State of Colorado and acceptable to Owner.
- B. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.
- C. Control datum for survey is indicated on Drawings.
- D. Verify setbacks and easements; confirm Drawing dimensions and elevations.
- E. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.

- F. Submit copy of site drawing and certificate signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.
- G. Maintain complete and accurate log of control and survey Work as Work progresses.
- H. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.
- I. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.
- J. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

### 1.3 CLOSEOUT PROCEDURES

- A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:
  - 1. Obtain certificate of occupancy from City of Thornton Building Department.
  - 2. Submit maintenance manuals, Project record documents, digital images of construction photographs, and other similar final record data in compliance with this Section.
  - 3. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
  - 4. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
  - 5. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
  - 6. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
  - 7. Make final change-over of locks and transmit keys directly to Owner. Advise Owner's personnel of change-over in security provisions.
  - 8. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
  - 9. Perform final cleaning according to this Section.
- B. Substantial Completion Inspection:
  - 1. When Contractor considers Work to be substantially complete, submit to Owner:

- a. Written certificate that Work, or designated portion, is substantially complete.
    - b. List of items to be completed or corrected (initial punch list).
  2. Within seven days after receipt of request for Substantial Completion, Owner will make inspection to determine whether Work or designated portion is substantially complete.
  3. Should Owner determine that Work is not substantially complete:
    - a. Owner will promptly notify Contractor in writing, stating reasons for its opinion.
    - b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Owner.
    - c. Owner will reinspect Work.
    - d. Redo and Inspection of Deficient Work: Repeated until Work passes Owner's inspection.
  4. When Owner finds that Work is substantially complete, Owner will:
    - a. Prepare Certificate of Substantial Completion accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
    - b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.
  5. After Work is substantially complete, Contractor shall:
    - a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
    - b. Complete Work listed for completion or correction within time period stipulated.
- C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.
1. When Contractor considers Work to be complete, submit written certification that:
    - a. Contract Documents have been reviewed.
    - b. Work has been examined for compliance with Contract Documents.
    - c. Work has been completed according to Contract Documents.
    - d. Work is completed and ready for final inspection.
  2. Submittals: Submit following:
    - a. Final punch list indicating all items have been completed or corrected.



- b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
  - c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
  - d. Accounting statement for final changes to Contract Sum.
  - e. Contractor's affidavit of payment of debts and claims.
  - f. Contractor affidavit of release of liens.
  - g. Consent of surety to final payment.
3. Perform final cleaning for Contractor-soiled areas according to this Section.
- D. Final Completion Inspection:
- 1. Within seven days after receipt of request for final inspection, [Owner] will make inspection to determine whether Work or designated portion is complete.
  - 2. Should Owner consider Work to be incomplete or defective:
    - a. Owner will promptly notify Contractor in writing, listing incomplete or defective Work.
    - b. Contractor shall remedy stated deficiencies and send second written request to Owner that Work is complete.
    - c. Owner will reinspect Work.
    - d. Redo and Inspection of Deficient Work: Repeated until Work passes Owner's inspection.

#### 1.4 STARTING OF SYSTEMS

- A. Coordinate schedule for startup of various equipment and systems.
- B. Notify Owner seven days prior to startup of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify that tests, meter readings, and electrical characteristics agree with those required by Equipment or System Manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute startup under supervision of Manufacturer's representative or Contractors' personnel according to Manufacturer's instructions.
- G. When specified in individual Specification Sections, require Manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve

equipment or system installation prior to startup and will supervise placing equipment or system in operation.

#### 1.5 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of substantial completion.
- B. Demonstrate Project equipment and instruct equipment by authorized Manufacturer's representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at designated location.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. Required instruction time for each item of equipment and system is specified in individual Specification Sections.

#### 1.6 PROJECT RECORD DOCUMENTS

- A. Maintain on Site one set of the following record documents; record actual revisions to the Work:
  - 1. Drawings.
  - 2. Specifications.
  - 3. Addenda.
  - 4. Change Orders and other modifications to the Contract.
  - 5. Reviewed Shop Drawings, product data, and Samples.
  - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:
  - 1. Manufacturer's name and product model and number.

2. Product substitutions or alternates used.
  3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:
1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
  2. Include locations of concealed elements of the Work.
  3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
  4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
  5. Identify and locate existing buried or concealed items encountered during Project.
  6. Measured depths of foundations in relation to finish floor datum.
  7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  9. Field changes of dimension and detail.
  10. Details not on original Drawings.
- G. Submit marked-up paper copy documents to Engineer with claim for final Application for Payment.
- H. Submit PDF electronic files of marked-up documents to Engineer with claim for final Application for Payment.

#### 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit in PDF composite electronic indexed file.
- B. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
  2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:
    - a. Significant design criteria.

- b. List of equipment.
  - c. Parts list for each component.
  - d. Operating instructions.
  - e. Maintenance instructions for equipment and systems.
  - f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
  - g. Safety precautions to be taken when operating and maintaining or working near equipment.
3. Part 3: Project documents and certificates, including the following:
- a. Shop Drawings and product data.
  - b. Air and water balance reports.
  - c. Certificates.
  - d. Photocopies of warranties.

#### 1.8 MANUAL FOR MATERIALS AND FINISHES

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to final inspection Draft copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit in PDF composite electronic indexed file of final manual within fifteen days after final inspection.
- E. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom-manufactured products.
- F. Instructions for Care and Maintenance: Include Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- G. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- H. Additional Requirements: As specified in individual product Specification Sections.

- I. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

#### 1.9 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit in PDF composite electronic indexed file of final manual within fifteen days after final inspection.
- E. Each Item of Equipment and Each System: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; by label machine.
- G. Include color-coded wiring diagrams as installed.
- H. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.
- I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- J. Include servicing and lubrication schedule and list of lubricants required.
- K. Include Manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by Controls Manufacturer.
- M. Include original Manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Include control diagrams by Controls Manufacturer as installed.
- O. Include Contractor's coordination drawings with color-coded piping diagrams as installed.
- P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

- Q. Include list of original Manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.
- S. Additional Requirements: As specified in individual product Specification Sections.
- T. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

#### 1.10 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within fifteen days after completion of applicable item of Work.
- B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Include table of contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time of Submittals:
  - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within fifteen days after acceptance.
  - 2. Make other submittals within fifteen days after date of Substantial Completion, prior to final Application for Payment.
  - 3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within fifteen days after acceptance, listing date of acceptance as beginning of warranty or bond period.

#### 1.11 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in Specification Sections during warranty period.
- B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by Manufacturer of original component.
- D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual Specification Sections.
- D. Verify that utility services are available with correct characteristics and in correct locations.

### 3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance according to Manufacturer's instructions.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply Manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

### 3.3 EXECUTION

- A. Comply with Manufacturer's installation instructions, performing each step in sequence. Maintain one set of Manufacturer's installation instructions at Project Site during installation and until completion of construction.
- B. When Manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by Manufacturer.
- D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
  - 1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
  - 2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
  - 3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.
- E. Allow for expansion of materials and building movement.

- F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.
  - 1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
  - 2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.
- G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.
  - 1. Refer questionable mounting heights choices to Engineer for final decision.
  - 2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.
- H. Adjust operating products and equipment to ensure smooth and unhindered operation.
- I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by Manufacturer.

#### 3.4 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from Waterproofing or Roofing Material Manufacturer.
- F. Prohibit traffic from landscaped areas.

#### 3.5 FINAL CLEANING

- A. Execute final cleaning prior to final Project assessment.
  - 1. Employ experienced personnel or professional cleaning firm.
- B. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.
- C. Replace filters of operating equipment.
- D. Clean debris from roofs, gutters, downspouts, and drainage systems.



- E. Clean Site; sweep paved areas, rake clean landscaped surfaces.
- F. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION

## SECTION 01 75 00 - TESTING, TRAINING, AND COMMISSIONING

### PART 1 GENERAL

#### 1.1 SCOPE

This section specifies equipment and system testing and start-up, services of Manufacturer's representatives, training of Owner's personnel, and final testing requirements for the complete facility.

#### 1.2 CONTRACT REQUIREMENTS

- A. Testing, training, and start-up are requisite to the satisfactory completion of the Contract.
- B. Complete all testing, training, and start-up within the Contract Time(s).
- C. Furnish all necessary labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.
- D. Provide competent, experienced technical representatives of Equipment Manufacturers for assembly, installation, testing, and operator training.

#### 1.3 START-UP PLAN

- A. Submit start-up plan for each piece of equipment and each system not less than 2 weeks prior to planned initial equipment or system start-up.
- B. Provide detailed Start-up Progress Schedule with the following activities identified:
  - 1. Manufacturer's services
  - 2. Installation certifications
  - 3. Operator training
  - 4. Submission of operation and maintenance manual
  - 5. Functional testing
  - 6. Performance testing
  - 7. Operational testing
- C. Provide testing plan with test logs for each item of equipment and/or system. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
- D. Provide summary of shutdown requirements for existing systems if required, which are necessary to complete start-up of new equipment and systems.

- E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

#### 1.4 GENERAL START-UP AND TESTING PROCEDURES

##### A. Mechanical Systems:

1. Remove rust preventatives and oils applied to protect equipment during construction.
2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by Manufacturer.
3. Flush fuel system and provide fuel for testing and start-up.
4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
7. Perform cold alignment and hot alignment to Manufacturer's tolerances.
8. Adjust V-belt tension and variable pitch sheaves.
9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to ensure no leakage but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

##### B. Electrical Systems

1. Perform insulation resistance tests on wiring except 120-volt lighting, wiring, and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
5. Check motors for actual full load amperage draw. Compare to nameplate value.

##### C. Instrumentation Systems

1. Bench or field calibrate instruments and make required adjustments and control point settings.
2. Leak test pneumatic controls and instrument air piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

#### 1.5 FUNCTIONAL TESTING

- A. Functionally test mechanical and electrical equipment for proper operation after general start-up and testing tasks have been completed.
- B. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the Manufacturer's representative.
- C. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.
- D. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

#### 1.6 CERTIFICATE OF PROPER INSTALLATION

- A. At completion of functional testing, furnish written report prepared and signed by Manufacturer's authorized representative, certifying equipment:
  1. Has been properly installed, aligned, adjusted, and lubricated.
  2. Is free of any stresses imposed by connecting piping or anchor bolts.
  3. Is suitable for satisfactory full-time operation under full load conditions.
  4. Operates within the allowable limits for vibration.
  5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
  6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly functioning.
- B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
  1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
  2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.

- C. Co-sign the reports along with the Manufacturer's representative and subcontractors.

#### 1.7 TRAINING OF OWNER'S PERSONNEL

- A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize Manufacturer's representatives to conduct training sessions.
- B. Coordinate training schedule with City staff. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than two sessions per week.
- C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 2 weeks prior to training session for that piece of equipment or system.
- D. Satisfactorily complete functional testing before beginning operator training.
- E. The Owner may videotape the training for later use with the Owner's personnel.

#### 1.8 OPERATIONAL TESTING

- A. Conduct operational test of the entire facility after completion of operator training. Demonstrate satisfactory operation of equipment and systems in actual operation.
- B. Conduct operational test for continuous 7-day period.
- C. Owner will provide operations personnel, power, fuel, and other consumables for duration of test.
- D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.
- E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

#### 1.9 RECORD KEEPING

- A. Maintain and submit to Engineer the following records generated during start-up and testing phase of Project:
  - 1. Daily logs of equipment testing identifying all tests conducted and outcome.
  - 2. Logs of time spent by Manufacturer's representatives performing services on the job site.
  - 3. Equipment lubrication records.
  - 4. Electrical phase, voltage, and amperage measurements.
  - 5. Insulation resistance measurements.
  - 6. Pump torsional and lateral vibration analysis report.

7. Data sheets of control loop testing including testing and calibration of instrumentation devices and set points.

END OF SECTION

## SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

### PART 1 GENERAL

#### 1.1 DESCRIPTION

- A. This section includes procedural requirements for providing, compiling, and submitting operation and maintenance data required for this Project.

#### 1.2 SUMMARY

- A. This section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. General contents of data.
  - 2. Specific data for each equipment and system.
  - 3. Manual for materials and finishes.
  - 4. Assembly.

#### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.4 SUBMITTALS

- A. O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized by this Section and as defined in Section 01 33 00.
  - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Manual Submittal: Submit an electronic copy of each manual in final form prior to requesting inspection for Substantial Completion and as defined in Section 01 33 00. Engineer will return an electronic copy with comments.
  - 1. The Contractor to correct or revise each manual to comply with Engineer's comments.
- C. Submit one electronic and 3 hard copies of each corrected manual as a final manual within 15 days of receipt of Engineer's comments and prior to commencing startup, commissioning, and/or training.

D. After acceptance, deliver one electronic copy to the Engineer.

#### 1.5 FORMAT (HARDCOPY)

- A. Prepare data in the form of an O&M instructional manual.
- B. Binders: Commercial quality, 8-1/2 x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings. Three ring binders are not acceptable.
- C. Arrange contents by Specification Section numbers and sequence of Table of Contents of this Project Manual.
- D. Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.
- E. Text: Manufacturer's printed data, or typewritten data on 20-pound paper.
- F. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three-hole post binders.

#### 1.6 FORMAT (ELECTRONIC DOCUMENTATION)

- A. The Contractor must provide Operation and Maintenance Manual information specific to the configuration of the Project in electronic form that is substantively the same as that hard copy materials. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that the Owner is able to load the files onto a server to provide online access via any standard web browser. The Contractor shall make use of HTML (for text-based documents) and PDF (for CAD type drawings) file formats. The complete document shall be provided on a flash drive.
- B. The electronic O&M data must be organized in a logical manner to aid operation in troubleshooting and information retrieval.

#### 1.7 QUALITY ASSURANCE

- A. Preparation of data shall be performed by personnel:
  - 1. Trained and experienced in O&M of described equipment.
  - 2. Familiar with requirements of this section.
  - 3. Skilled as technical writers to the extent required to communicate the essential data to the Reader.
  - 4. Skilled as drafters competent to prepare any required drawings.

#### 1.8 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION" are part of this Specification.



1. 01 78 23A, Contractor Submittal Form
2. 01 78 23B, Equipment Data Form

PART 2 PRODUCTS - (Not Used)

PART 3 EXECUTION

3.1 GENERAL CONTENTS OF DATA

- A. Each individual manual shall contain equipment data pertaining to not more than one Specification section number as indicated in the Contract Documents.
- B. Title Sheet: First page in data listing following:
  1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS".
  2. Title of Project: As shown on Contract Documents.
  3. Name(s) of applicable building(s) or structure(s) in which equipment is located.
  4. Name of equipment as described in Contract Documents.
  5. Contractor's name, address, and telephone number.
  6. Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.
  7. Contractor's or Subcontractor's purchase order number, Manufacturer's shop order number or other such numbers required for parts and service ordering.
  8. Manufacturer's name, address, and telephone number.
  9. Name, address, and telephone number for local source of supply for parts and service.
- C. Equipment List: Immediately following title sheet containing the following:
  1. Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.
  2. Tabbed Dividers: Insert tabbed section dividers between each major section
    - a. Provide title of section on each tab.
    - b. Provide table of contents for each tabbed section, arranged in systematic order.
  3. Equipment Data Sheets: Provide catalog sheets showing configuration, Manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).
  4. Text:

- a. Include only those sheets applicable to Project.
  - b. Each sheet shall:
    - 1) Identify specific equipment or part installed.
    - 2) Identify text applicable to equipment or part installed.
    - 3) Do not include inapplicable information or neatly strike it out.
5. Drawings:
- a. Supplement text with drawings to clearly illustrate following:
    - 1) Equipment and components.
    - 2) Relations of component parts of equipment and systems.
    - 3) Control and flow diagrams.
  - b. Actual drawings of equipment from Manufacturer. "Typical" drawings are not acceptable unless they accurately illustrate actual installation for this contract.
6. Specially written information, as required to supplement text for particular installation.
- a. Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.
  - b. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
  - c. Provide glossary of any special terms used by the Manufacturer if applicable.
  - d. Organize in consistent format under separate headings for different O&M procedures.
  - e. Provide logical sequence of instructions in order of O&M action required for each procedure.

### 3.2 SPECIFIC DATA FOR EACH ITEM AND/OR SYSTEM

- A. For each item of equipment and system include:
  - 1. Completed Equipment Data Form (01 78 23B). An electronic copy of the form can be provided to the Contractor upon request.
  - 2. Description of equipment and component parts:
    - a. Function
    - b. Normal operating characteristics
    - c. Limiting conditions.
    - d. Performance curves

- e. Engineering data
  - f. Test as applicable.
  - g. Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.
  - h. Complete nameplate data.
  - i. Owner's tag (or asset) numbers for equipment as indicated on the Contract Drawings.
3. Operating Procedures:
- a. Startup and break-in.
  - b. Normal operating instructions.
  - c. Regulation and control
  - d. Stopping and shutdown,
  - e. Emergency instructions.
  - f. Summer and winter operating instructions, as applicable.
  - g. Special operating instructions.
4. Maintenance Procedures:
- a. Routine maintenance operations.
  - b. Guide to troubleshooting.
  - c. Disassembly, repair, and reassembly instructions.
  - d. Alignment, adjusting, and checking instructions.
5. Servicing and Lubrication Schedule:
- a. List of lubricants required and quantity to be applied.
  - b. Schedule of lubrication.
  - c. Schedule for other routine maintenance.
6. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.
7. Description of sequence of operation of controls.
8. Assembly drawings and diagrams required for maintenance.
9. Manufacturer's parts list and illustrations

- a. Predicted life of parts subject to wear.
  - b. Items recommended to be stocked by the Owner as spare parts and quantities of same.
10. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.
11. Bill of material.
12. Other data as required under applicable Specification sections.
- B. Each electric and electronic system, as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include:
  1. Description of System and Component Parts:
    - a. Function
    - b. Normal operating characteristics
    - c. Limiting conditions.
    - d. Performance curves
    - e. Engineering data
    - f. Rating tables
    - g. Tests, as applicable.
    - h. Complete nomenclature and model number of replaceable parts.
    - i. Complete nameplate data.
    - j. Owner's Tag (asset) numbers for equipment as indicated on the Contract Drawings.
  2. Circuit Directories of Panel Boards:
    - a. Electrical service.
    - b. Controls.
    - c. Communications.
  3. Complete instrumentation
    - a. Loop diagrams
    - b. Tabulated listing of components in each control circuit or loop.
  4. Operating Procedures:
    - a. Routine and normal operating instructions.

- b. Sequences required.
    - c. Special operating instructions.
  - 5. Maintenance Procedures:
    - a. Routine maintenance operations.
    - b. Guide to troubleshooting.
    - c. Disassembly, repair, and reassembly instructions.
    - d. Adjustment and checking instructions.
  - 6. Manufacturer's printed instructions regarding safety precautions for both:
    - a. Protection of personnel operating equipment and systems.
    - b. Prevention of damage to equipment and systems.
  - 7. List of original all of the Manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by the Owner.
  - 8. Other data as required under pertinent sections of Specifications.
- C. Prepare and include additional data when need for such data becomes apparent during instruction of Owner's personnel. Differences between the equipment O&M manual and the Manufacturer's training session shall result in the training and/or O&M Manual being corrected.

### 3.3 MANUAL FOR MATERIAL AND FINISHES

- A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: As specified in individual product specification sections.
- E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

### 3.4 ASSEMBLY

- A. Assemble in 3 sets.

- B. Remove bindings of individual manuals.
- C. Insert index tabs labeled with the respective piece of equipment to separate individual manuals.
- D. Provide a Table of Contents at the front of each volume showing the equipment items in the order in which they appear in the volume. Each equipment items shall include the functional name, applicable specifications section, and the plan listing, if any.
- E. The preventive maintenance schedule shall be bound in the front of each section immediately following the index tab sheet. The schedule shall be identified with respect to the piece of equipment it is referring to.
- F. Sheet Size: 8-1/2 x 11 sheets.
- G. Drawings may be on 11 x 17-inch sheets folded to 8-1/2 x 11 inches.
- H. Engrave on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, Owner's project number, date of Contract, and volume number with subject matter of contents, and Engineer's name.

END OF SECTION

## SECTION 02 30 00 - SUBSURFACE INVESTIGATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Subsurface investigations and reporting have been performed for the purpose of obtaining data for the planning and design of this Project. Copies of such reporting are attached to the Contract Documents as Supplementary Information.

#### 1.2 LIMITATIONS

- A. The subsurface investigations and reporting are being made available solely for the convenience of the Bidder and shall not relieve the Bidder or the Contractor of any risk, duty to make examinations and investigations as required by Article 4 of the Instructions to Bidders, or any other responsibility under the Contract Documents.
- B. It is mutually agreed to by all parties:
  - 1. Written reports are reference documents and are not part of the Contract Documents.
  - 2. Subsurface investigations are for the purpose of obtaining data for planning and design of the Project.
  - 3. Data concerning borings and test pits is intended to represent with reasonable accuracy conditions and material found in specific borings and test pits at the time the borings and test pits were made.
- C. It is expressly understood and agreed the Owner and Engineer assume no responsibility whatsoever in respect to the sufficiency or accuracy of the investigation thus made, the records thereof, or of the interpretations set forth therein, or made by the Owner in the Owner's use thereof; and there is no warranty or guarantee, either expressed or implied, that the conditions indicated by such investigations, or records thereof, are representative of those existing throughout such areas, or any part, or that unforeseen developments may not occur.
- D. The Owner's subsurface investigations and reporting are made available to Bidder or Contractor only on the basis of the understandings and agreement herein stated.

### PART 2 PRODUCTS - Not Used

### PART 3 EXECUTION - Not Used

END OF SECTION

## SECTION 02 41 00 - DEMOLITION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of existing facilities.
  - 2. Abandoning and removing utilities.
- B. Related Sections:
  - 1. Section 31 10 00 - Site Clearing
  - 2. Section 31 22 13 - Rough Grading

#### 1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Submit to Engineer a copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

#### 1.3 QUALITY ASSURANCE

- A. Existing Conditions: Determine the extent of work required and limitations before proceeding with Work.
- B. Conform to applicable local, state, and federal codes for environmental requirements in relation to disposal of debris.
  - 1. Burning at the Site for the disposal of refuse, debris, and waste materials resulting from demolition and site clearing operations shall not be permitted.
- C. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.
- D. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of workmen, other persons, and property in the vicinity of the Work and requirements of the General Provisions.
- E. If the existing material to be demolished and removed contains any hazardous materials which will require special handling upon removal, such as asbestos or lead,



it is the responsibility of the Contractor to remove and dispose of the material in accordance with all applicable federal, state, and local regulations.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring, or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or Specifications.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. The Owner assumes no responsibility for the actual condition of the facilities to be demolished. The Contractor shall visit the site, inspect all facilities and be familiar with all existing conditions and utilities.
- B. Demolition drawings identify major equipment and structures to be demolished only. Auxiliary utilities such as water, air, chemicals, drainage, lubrication oil, hydraulic power fluid, electrical wiring, controls, and instrumentation are not necessarily shown shall be considered incidental to all demolition work.
- C. Identify waste and salvage areas for placing removed materials.

### 3.2 PREPARATION

- A. Carefully coordinate the work of this Section with all other work and construction.
- B. Call Local Utility Line Information service at 811, not less than three working days before performing Work.
  - 1. Request underground utilities to be located and marked within and surrounding construction areas.
  - 2. Disconnect or arrange for disconnection of utilities (if any) affected by required work.
  - 3. Keep all active utilities intact and in continuous operations.

### 3.3 PROTECTION

- A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.
- B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.
- C. Landscaped Areas: Protect existing landscaped areas as specified in Section 31 10 00-3.4.D, Site Clearing.
- D. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, guy wires, utility poles, and curbs.
- E. Repair and Replacement:
  - 1. Damaged items, including but not restricted to those noted above, shall be repaired, or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of Work of this contract.
  - 2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

### 3.4 DEMOLITIONS

- A. Areas which are to be excavated for the purpose of demolition shall be cleared and stripped in accordance with Section 31 10 00-3.6, Site Clearing.
- B. Carefully consider all bearing loads and capacities for placement of equipment and material on site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, consult with Engineer prior to the placement of such equipment or material.
- C. Demolition of Existing Structures:
  - 1. Excavate around existing structures as required to perform demolition operations and to plug associated existing pipelines where shown in the Drawing.
  - 2. Provide shoring, bracing, and supports, as required, to ensure adjacent structures are not damaged and structural elements of existing structure are not overloaded during demolition activities.

- a. Increase structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this Contract.
    - b. Remove all temporary protection when the Work is complete or when so authorized by the Engineer.
  3. Any floors that are to remain in place shall be completely cracked through to allow for drainage. Cracking shall be accomplished by dropping a demolition ball or by other methods approved by the Engineer.
  4. Remove and dispose of all exposed and/or protruding metalwork, piping, plumbing, and conduits resulting from demolition activities, and all woodwork, roofing, and electrical and mechanical equipment removed from demolished structures.
    - a. Reinforcing bars shall be cut flush with final wall elevations as shown in the Drawings.
    - b. No detached metalwork, excluding concrete reinforcing bars, shall be buried with the concrete and masonry rubble.
- D. Backfill at Demolished Structures:
1. For structures designated to be abandoned and/or demolished in place, concrete and/or masonry rubble and excavated soils resulting from demolition activities shall be used for backfill or placed in the bottoms of said structures only as directed by the Engineer.
  2. Concrete and masonry rubble used for backfilling shall be broken into pieces no larger than 12 inches on any one side.
  3. Materials resulting from abandonment/demolition activities approved for backfill shall be combined with imported filler sand to create a dense, compacted backfill.
  4. Backfilling or placement of the excavated material in the structures shall meet the following requirements.
    - a. Furnish, place and compact filler sand along with the concrete and masonry rubble so that all voids are filled and a dense, compacted backfill is obtained.
    - b. Filler sand shall be placed in horizontal layers completely filling all voids between pieces of rubble and not exceeding 12 inches in thickness.
    - c. Each layer of filler sand shall be compacted to obtain at least 95 percent of maximum density as determined by ASTM Method D-698-78 (AASHTO T-99).

- d. Water shall be furnished by the Contractor and added to each layer as required to maintain optimum moisture content.
  - e. The amount of filler sand used shall only be the amount needed to fill all voids created by placement of the concrete and asphalt rubble, as directed by the Engineer.
  - f. At locations where concrete and masonry rubble are used for backfill, they shall be placed such that a minimum of 3 feet of compacted non-rubble backfill material (crushed rock) exists between any rubble and finished grade. Protruding reinforcing bars shall be cut to lengths that allow granular backfill to be placed and compacted to required levels in and above the rubble.
- 5. Disposal of all materials not used for backfill shall be performed off-site and in compliance with applicable local, state, and federal codes and requirements.
  - 6. In areas where new construction will take place, no trace of these structures shall remain prior to placing of backfill.
- E. Backfilling within the footprint of new structures with rubble material resulting from demolition activities will not be allowed.
  - F. All existing improvements designated in the Drawings or specified to be removed, including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the demolition work.
  - G. Unless otherwise specified, any resulting voids shall be backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.

### 3.5 REMOVAL

- A. Remove debris, rock, excavated materials, rubble, abandoned piping, and extracted plant life resulting from abandonment and/or demolition activities from site.
- B. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- C. Removal: All material resulting from demolition, clearing, and grubbing, and trimming operations shall be removed from the Project Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.

### 3.6 GRADING

- A. All grading work shall be completed in accordance with Section 31 22 13, Rough Grading.

### 3.7 CLEANUP

- A. During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, debris, and dust and shall leave all areas affected by the work in a clean, condition, as may be subject to Engineer approval.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris resulting from demolition.
- C. Adjacent areas shall be returned to their existing condition prior to the start of work.

END OF SECTION

## SECTION 03 11 00 - CONCRETE WORK

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. The extent of concrete work is shown on the Drawings.
- B. Work includes providing formwork and shoring for cast-in-place concrete and installation into formwork of items such as reinforcing steel bar (rebar), anchor bolts, setting plates, bearing plates, anchorages, inserts, reveals, frames, nosings, sleeves and other items to be embedded in concrete.

#### 1.2 QUALITY ASSURANCE

##### A. Codes and Standards

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified here:

##### 1. ASTM International (ASTM)

- a. C31, Making and Curing Concrete Test Specimens in the Field
- b. C33, Specification for Concrete Aggregate
- c. C39, Compressive Strength of Cylindrical Concrete Specimens
- d. C40, Organic Impurities in Fine Aggregate for Concrete
- e. C85, Cement Content of Hardened Portland Cement Concrete
- f. C88, Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
- g. C94, Standard Specifications for Ready-Mixed Concrete
- h. C131, Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- i. C136, Method for Sieve Analysis to Fine and Coarse Aggregate
- j. C143, Slump of Portland Cement Concrete
- k. C150, Standard Specification for Portland Cement
- l. C156, Water Retention by Concrete Curing Materials

- m. C173, Air Content of Freshly Mixed Concrete by the Volumetric Method
  - n. C231, Air Content of Freshly Mixed Concrete by the Pressure Method
  - o. C233, Standard Method of Testing Air-Entraining Admixtures for Concrete
  - p. C260, Standard Specifications for Air-Entraining Admixtures for Concrete
  - q. C289, Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
  - r. C441, Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction
  - s. C457, Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete
  - t. C494, Standard Specifications for Chemical Admixtures for Concrete
  - u. C670, Preparing Precision Statements for Test Methods for Construction Materials
  - v. C803, Penetration Resistance of Hardened Concrete
2. American Concrete Institute (ACI)
- a. ACI 301 “Specifications for Structural Concrete for Buildings”
  - b. ACI 311 “Recommended Practice for Concrete Inspection”
  - c. ACI 304 “Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete”

B. Workmanship

The Contractor is responsible for correction of concrete work that does not conform to the specified requirements, including strength, tolerances, and finishes. Correct deficient concrete as directed by the Engineer. The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

C. Concrete Testing Service

The Owner or a representative of the Owner will engage a special inspector/testing laboratory to perform material evaluation tests and to design concrete mixes. See detailed requirements in Part 3.14 “Quality Control Testing during Construction”. Per

the Owner or Engineer's requirements the Contractor shall notify the designated representative to schedule the special inspections and materials testing required by the Project documents.

D. Testing Requirements

Materials and installed work may require testing and retesting, as directed by the Engineer, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. All testing, including the retesting of rejected materials and installed work shall be done at the Contractor's expense.

E. Tests for Concrete Materials

1. Test aggregates by the methods of sampling and testing of ASTM C33.
2. For Portland cement, sample the cement and determine the properties by the methods of test of ASTM C150.
3. Submit written reports to the Engineer, for each material sampled and tested prior to the start of work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, Material Manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.
4. Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing. The materials producer and the Contractor must sign certificates of compliance.

F. Allowable Tolerances:

1. Construct formwork to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 347, and as follows:
  - a. Variation from plumb in lines and surfaces of columns, piers, walls and rises; 1/4-inch per 10 feet, but not more than 1-inch. For exposed corner columns, control joint grooves, and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum; 1/2-inch maximum in 40 feet or more.
  - b. Variation from level or grade in slab soffits, ceilings, beam soffits, and rises 1/4-inch in 10 feet, 3/8-inch in any bay or 20 feet maximum, and 3/4-inch in 40 feet or more. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum and 1/2-inch in 40 feet or more.



- c. Variation from position of the linear lines and related columns, walls, and partitions, 1/2-inch in any bay or 20 feet maximum, and 1-inch in 40 feet or more.
  - d. Variation in sizes and locations of sleeves, floor openings, and wall openings, 1/4-inch.
  - e. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls, minus 1/4-inch and plus 1/2-inch.
  - f. Variations in footing plan dimensions, minus 1/2-inch and plus 2 inches; misplacement or eccentricity, 2 percent of the footing width in direction of misplacement but not more than 2 inches; thickness reduction, minus 5 percent.
  - g. Variation in steps - In a flight of stairs, 1/8-inch for rise and 1/4-inch for treads; in consecutive steps, 1/16-inch for rise and 1/8-inch for treads.
  - h. Circular structures shall be constructed in a true circular form, with maximum variation of 1/4-inch from the dimensions shown on the plans.
- 2. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.
  - 3. During concrete placement check formwork and related supports to ensure that forms are not displaced, and that completed work will be within specified tolerances.

G. Quality Control Testing During Construction

See Section 3 - Execution.

1.3 SUBMITTALS

- A. For information only, submit six copies of Manufacturer's data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, chemical floor hardeners, dry-shake finish materials, and others. Bind and submit in one submittal.
- B. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with the ACE 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete structures.

- C. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually. Submit form drawings for building columns, walls, fascias, and intersections, and concrete pan and joist system. Submit for typical sections only. Engineer's review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is the Contractor's responsibility.
- D. Submit six copies of laboratory test reports for concrete materials and mix design tests as specified.
- E. Material Certificates may be provided in lieu of materials laboratory test reports. The Material Manufacturer and the Contractor, certifying that each material item complies with, or exceeds, the specified requirements shall sign material certificates.

#### 1.4 CONCRETE MIX DESIGNS

- A. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.
- B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier or if directed by the Engineer, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7-, 14- and 28-day strengths versus slump values of 2, 4, and 6 inches, all conforming to these Specifications, shall be established by an approved ready-mix supplier or an independent testing laboratory. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders. The costs for preparation of mix designs (if required by the Owner to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the Contractor.
- C. The exact proportions by weight of all materials entering into the concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the Engineer or Laboratory for improved specified strength or desired density, uniformity and workability.
- D. The proportions of such mix design shall be based on a full cubic yard of hardened concrete.
- E. Ready-mix companies or jobsite batch plants shall furnish delivery tickets, signed by a Certified Weighmaster, on which each shall state the weight of aggregates, sand, cement, admixtures and water, and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.

- F. There shall be no variation in the weights and proportions of materials from the approved mix design.
- G. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.

## 1.5 READY-MIXED CONCRETE

The use of ready-mixed concrete in no way relieves the Contractor of the responsibility for proportion, mix, delivery, or placement of concrete; ready-mixed concrete shall conform to the requirements of the City of Thornton Standards & Specifications, ASTM C 94, and AASHTO M157. In case of conflict, ACI 301 shall govern.

## 1.6 JOB CONDITIONS

Maintain continuous traffic control and access for vehicular and pedestrian traffic as required for other construction activities as well as to adjoining facilities for regular operation. Utilize flagmen, barricades, warning signs and warning lights as required, to maintain a safe entrance and passage on all roads or drives abutting the Project.

## PART 2 PRODUCTS

### 2.1 WALL FORMS

- A. Full Height Pours: The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.
- B. Wall Form Ties
  - 1. Form ties which remain in the wall of a subgrade water-retaining structure shall have waterstops and a 1-inch minimum break back or cone depth.
  - 2. Snap ties, if used, shall not be broken until the concrete has reached the design concrete strength. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.
  - 3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess.

4. Ties shall positively secure the wall to the required dimension and hold the wall to that dimension prior to and during concrete placement.
- C. Wall Form Stiffeners
1. Horizontal walers shall consist of structural steel channels, angles, or tubing of adequate size to retain the concrete without deflecting.
  2. The walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacings of no more than 96 inches on center.
  3. There shall be at least one such waler within 24 inches of the top and bottom of the wall.
  4. The largest dimension of the steel waler shall be in the radial direction.
  5. Vertical structural steel or wood members shall be used at a minimum horizontal spacing of 74 inches and shall have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.
  6. In lieu of the above, a different system and spacings may be used if it is satisfactorily demonstrated to the Engineer that it will be equally effective.

## 2.2 FORMS FOR EXPOSED FINISH CONCRETE

Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Finish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection. Use overlaid plywood complying with U.S. Product Standard PS-1 "B-B High Density Overlaid Concrete Form", Class I. Use flexible spring steel forms or laminated boards free of distortion and defects to form radius bends as required.

## 2.3 FORMS FOR UNEXPOSED FINISH CONCRETE

- A. Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

## 2.4 FORM MATERIALS

- A. Form Coatings

Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound. Petroleum based coatings shall not be used for structures in creeks and waterways. Biodegradable coatings shall be used which will not contaminate the creeks/waterways or an alternate method for stripping the form shall be proposed.

B. Chamfers, Reveals, Drips

Provide preformed PVC or shaped wood or metal of size and profile as shown on drawings.

C. Cylindrical Columns and Supports

Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Provide units having “seamless” interior to minimize spiral gaps or seams.

D. Pan Forms

Provide forms for concrete pan-type construction complete with covers and end enclosures to form a true, clean, smooth concrete surface. Design units for easy removal without damaging placed concrete. Block adjoining pan units if required to avoid lateral deflection of formwork during concrete placement and compaction. Provide standard or tapered end forms, as shown.

If required, factory-fabricate pan form units to required sizes and shapes of the following:

1. Steel – 16-gauge minimum, free of dents, irregularities, sag, and rust, or
2. Glass-Fiber Reinforced Plastic - Molded under pressure with matched dies, 0.11 inches minimum wall thickness.

E. Inserts

Provide metal inserts for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Provide “Parabolt” by the Molly Company, “Phillips Red-Head”, or “Burke” products. The Contractor is responsible for ensuring that all required anchorage not specified in the Project documents is installed per current building code and applicable ICC report requirements.

## 2.5 REINFORCING STEEL

- A. Reinforcing Bar (rebar): ASTM A615 and as follows below

Stirrups and Ties                      Grade 60 (Grade 40 may be used for #3 and smaller)

All other Uses                          Grade 60

- B. Steel Wire: ASTM A82, plain, cold-drawn, steel.

- C. Welded Wire Fabric (WWF): ASTM A185, welded steel wire fabric; ASTM A-741, Specifications for welded steel wire fabric for concrete reinforcement; ASTM A-497, Specification for welded deformed steel wire fabric for concrete reinforcement.

- D. Supports for Reinforcement

Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars, and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise specified. Wood, brick, concrete blocks, and other devices will not be acceptable. For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base materials will not support chair legs. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are hot-dip galvanized, after fabrication, or plastic protected or stainless steel protected.

- E. Fibrous Concrete Reinforcement

1. Collated polypropylene fiber, 3/4-inch, manufactured from 100 percent virgin homopolymer polypropylene, hydrophobic, in compliance with ASTM C116.
2. Specific Gravity: 0.905 grams per cubic centimeter
3. Tensile Strength: 70 to 110 psi.
4. Accepted Manufacturer: Fibermesh Company, Buckeye Ultra Fiber 500, or approved equal.

## 2.6 CONCRETE MATERIALS

- A. Portland Cement

ASTM C150, Type II, unless otherwise acceptable to Engineer. Use only one brand of cement throughout the Project, unless otherwise acceptable to the Engineer. The use of ground granulated blast furnace slag is not allowed.

- B. Aggregates

ASTM C33. Provide aggregates from a single source for all exposed concrete.

Local aggregates not complying with ASTM C33, but which have shown by special test or actual service to produce concrete of adequate strength and durability, may be used when acceptable to the Engineer.

- C. Water: Potable, and clean and free from sand, oil, acid, alkali, organic matter, or other deleterious substances.
- D. Air Entraining Admixture: ASTM C260.
- E. Water-Reducing Admixture: ASTM C494, Type A.
- F. Set-Control Admixtures: ASTM C494, as follows:
  - 1. Type B, Retarding
  - 2. Type C, Accelerating
  - 3. Type D, Water-reducing and Retarding
  - 4. Type E, Water-reducing and Accelerating

Calcium chloride will not be permitted in concrete, unless otherwise authorized in writing by the Engineer.

## 2.7 RELATED MATERIALS

### A. Waterstops

Provide flat, dumbbell type, or centerbulb type waterstops at construction joints and other joints as shown. Size to suit joints or as shown. Provide PVC waterstops complying with Corps of Engineer's CRD-C 572. Waterstops to be Greenstreak 701 or equal. Split face waterstops will not be acceptable under any circumstances.

### B. Bituminous and Fiber Joint Filler

Provide resilient and non-extruding type pre-molded bituminous impregnated fiberboard units complying with ASTM D1751-73, and AASHTO M 213. Provide one of the following products:

- 1. Elastite; Philip Carey/Celotex
- 2. Flexcell; Celotex Corp.
- 3. Crane Fiber 1390; W.R. Grace & Co.

4. Fibre; W.R. Meadows, Inc.
  5. Tex-Lite; J & P Petroleum Prod. Inc.
  6. Sonoflex; Sonneborn/Contech, Inc.
- C. Form Ties (for forms other than wall forms)

Factory-fabricated, adjustable-length, removable or snap off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal. Unless otherwise shown, provide ties so portion remaining within concrete after removal is at least 1-1/2 inches inside concrete. Unless otherwise shown, provide form ties, which will not leave holes larger than 1-inch in diameter in concrete surface.

- D. Concrete Curing Materials

Acrylic curing and sealing compound - Water emulsion acrylic curing and sealing compound formulated of acrylic polymers of water-based carrier. W.R. Meadows, Inc. VOCOMP-20 or equal.

- E. Epoxy Adhesive

Provide Sikadur Hi-Mod (Sikastik 370) or Sikadur Hi-Mod Gel (Sikastix 390) for application to wire-brushed and prepared existing concrete to be mated to new concrete. Apply per Manufacturer's recommendations.

- F. Chemical-Hardener Finish: Provide Hornolith from Tamms Industries or equal.

- G. Non-slip Aggregate Finish

Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

- H. Non-shrink Grout: See Section 03 60 00, Grouting.

## 2.8 PROPORTIONING NORMAL CONCRETE

- A. Proportioning the "dry" constituents of concrete mixtures shall be accomplished by weighing. The responsible Party shall provide adequate and accurate scales for this work.
- B. There shall be no variance permitted in the minimum cement factor (sacks per cubic yard) as specified for the calls of concrete. The total quantity of mixing-water per sack of



cement, including free water in the aggregates, shall not exceed the maximum specified herein.

- C. The Responsible Party shall be responsible for developing the proper proportions of aggregates, cement and water that shall conform to the various requirements of these Standards and Specifications. Mix design shall be submitted to the Owner, along with at least two (2) sets of certified 28 day test results, for review and approval. No concrete shall be incorporated into the work until the proportions are approved by the Engineer.
- D. The slump shall be between 2 inches and 4 inches when tested in accordance with ASTM Specifications C 143. Variations in the slump range may be allowed by the Engineer if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured slump, the maximum allowable water-cement ratios as specified here-in, shall be strictly adhered to.
- E. Compressive Strength, Water and Cement Content

Notwithstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements. All concrete except as noted otherwise on the drawings shall have 4,500 pounds per square inch (psi) 28-day compressive strength. The maximum water content per 94-pound sack of cement is 4.5 gallons. The minimum cement content for the 4,500-psi mix is 6.0 sacks (94-pound sack of cement per cubic yard of concrete). Up to a maximum of 15 percent of cementitious material may be fly ash in accordance with ASTM C618. The use ground granulated blast furnace slag is not allowed.

- F. Retarding Densifiers
  - 1. All concrete (as defined in 2.9 below) used for wall construction shall also contain DARATARD-17, as manufactured by Grace Const. Products, Cambridge, MA or MBL-82, as manufactured by Master Builders, Cleveland, OH in the amounts recommended by the Additive Manufacturer whenever the air temperature during the pour exceeds 85 degrees Fahrenheit (F).
  - 2. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.
  - 3. Contractor shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

- G. Air-Entraining Agents

- 1. All concrete that that is specified to be air entrained or that may be exposed to freeze/thaw action either during construction or the service life of the structure

must be air entrained. Sufficient air-entraining agent shall be used to provide total air content of 5 percent, +/- 1 percent.

2. Air-entraining agents shall meet ASTM C 260, ASTM C 233 and ASTM C 457.
  3. The maximum total volumetric air content of the concrete before placement shall be 6 percent plus or minus one percent as determined by ASTM C 173 or ASTM 231.
  4. Subject to these Specifications, consideration will be given to the following products: PROTEX "AES," GRACE "DAREX AEA," MASTER BUILDERS "MB-AE10," or SIKA CHEMICAL "AER."
- H. Water Reducing Admixtures
1. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C 494, Type A or D.
  2. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.
  3. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.
  4. Superplasticizers, if allowed by the Engineer, shall conform to ASTM C 494, Type F or G, batch plant added using second or third generation only.
  5. Set control admixtures if allowed by the Engineer, shall conform to ASTM C 494, Type B (retarding) or Type C (accelerating).
- I. Fiber reinforcement admixture shall be included in the ready-mix concrete design used for filling and channeling the wet well chambers. Fibers shall be used in strict accordance with the Manufacturer's directions.

## 2.9 CONCRETE MIXING

Ready-Mix Concrete - Comply with the requirements of ASTM C94, and as herein specified. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required. When the air temperature is between 85 degrees F and 90 degrees F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes. Except by written authorization, concrete shall not be placed if the temperature of the plastic concrete cannot be maintained at or below 90 degrees F.

## PART 3 EXECUTION

### 3.1 FORMS

- A. Design, erect, support, brace, and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formworks so concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Design formworks to be readily removable without impact shock, or damage to cast-in-place concrete surfaces and adjacent materials.
- C. Construct forms complying with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- D. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- E. Erect falsework and support; brace and maintain it to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place concrete structures.

Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances.

- F. Forms for Exposed Concrete

Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes. Do not use metal cover plates for patching holes or defects in forms. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersections. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete.

Do not use narrow strips of form material, which will produce bow. Assemble forms so they may be readily removed without damage to exposed concrete surfaces. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

Corner Treatment - Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines, except as otherwise indicated.

- G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings of forms at inconspicuous locations.
- H. Chamfer exposed corners and edges, reveals and drips as shown using wood, metal, PVC or rubber strips fabricated to produce uniform smooth lines and tight edge joints.
- I. Provisions for Other Trades - Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such ties. Accurately place and securely support items built into forms.
- J. Cleaning and Tightening - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms after concrete placement if required to eliminate mortar leaks.

### 3.2 PLACING REINFORCEMENT

- A. Detail and place according to ACI Manual SP-66. Unless otherwise noted, minimum cover shall be in accordance to ACI 301, Section 5.5:
  - 1. Bottom bars on soil bearing foundations and slabs: three (3) inches.
  - 2. Bars adjacent to exposed surfaces or earth backfill:
    - a. For bars more than three-fourths ( $\frac{3}{4}$ ) inch in diameter: two (2) inches.
    - b. For bars three-fourths ( $\frac{3}{4}$ ) inch or less in diameter: one and one-half ( $1\frac{1}{2}$ ) inches.
  - 3. Interior Surfaces: slabs, walls, joints with one and three-eighths ( $1\frac{3}{8}$ ) inch diameter or smaller: three-fourths ( $\frac{3}{4}$ ) inch.
- B. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Do not place reinforcing bars more than 2 inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus 2 inches, and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

### 3.3 JOINTS

- A. Construction Joints - Locate and install construction joints, which are not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the Engineer.
- B. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints. Unless otherwise specified, reinforcement shall be lapped in accordance with ACI Standards.
- C. Waterstops - Install waterstops to form a continuous diaphragm in each joint. Make provisions to support and protect waterstops during the progress of the work. Fabricate field joints in waterstops in accordance with Manufacturer's printed instructions. Protect waterstop material from damage where it protrudes from any joint.
- D. Isolation Joints in Slabs-on-Ground - Construct isolation joints in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
- E. Control Joints in Slabs-on-Ground - Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4-inch wide by one-fifth to one-fourth of the slab depth, unless otherwise shown.
  - 1. Form control joints by inserting a pre-molded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured, remove inserts and clean groove of loose debris.
  - 2. Joint sealant material shall be as specified above.

### 3.4 INSTALLATION OF EMBEDDED ITEMS

- A. General - Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto.
- B. Edge Forms and Screed Strips for Slabs - Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.
- C. Cast in Place Reglets - Place in straight and continuous lines as detailed to enable flashing to be applied continuously without deviation at reglet joints more than 1/8-inch. Miter corners for continuous reglet joint where outside corners occur. At inside corners extend one section 1-inch past corner. Adequately anchor or secure reglets per Manufacturer's instructions prior to pouring and during construction to insure dimensional tolerances and alignment. Vibrate concrete to insure concrete cover adjacent to and around reglet. Visually inspect after pour and patch as required.

### 3.5 PREPARATION OF FORM SURFACES

Coat the contact surfaces of forms with a form-coating compound before reinforcement is placed. Thin formcoating compounds only with thinning agent of type, and in amount, and under conditions of the Form-coating Compound Manufacturer's directions. Use dissipating-type form oil at surfaces to receive cement plaster finish. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with Manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

### 3.6 CONCRETE PLACEMENT

- A. Pre-Placement Inspection
  - 1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work as required. Notify Engineer in time for inspection prior to pouring.
  - 2. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.
  - 3. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

4. Concrete Curbs and Paving - Do not place concrete until subbase is completed and approved by the Engineer as required to provide uniform dampened condition at the time concrete is placed. Moisten subbase as required to provide uniform dampened condition at the time concrete is placed.
- B. Place concrete in compliance with the practices and recommendations of ACI 304 and as herein specified.
1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete, which is being integrated, with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to re-handling or flowing. Do not subject concrete to any procedure, which will cause segregation.
  2. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.
  3. Do not use concrete which becomes non-plastic and unworkable or does not meet the required quality control limits or which has been contaminated by foreign materials. Do not use re-tempered concrete. Remove rejected concrete from the Project Site and dispose of in an acceptable location. Do not use concrete whose allowable mixing time has been exceeded.
- C. Concrete Conveying
1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods, which will prevent segregation and loss of concrete mix materials.
  2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.
  3. The Contractor shall provide traffic control on the narrow access roads to the work sites.
  4. The Contractor shall not wash concrete trucks/chutes/equipment off at the Project Site unless plastic tarps and hay bales are employed to contain the concrete. The Contractor will be required to haul off-site all concrete contaminated soil.
- D. Placing Concrete into Forms

1. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
2. Do not interrupt successive placement; do not permit cold joints to occur.
3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.
4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and Project conditions. Vibration of forms and reinforcing will not be permitted.
5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
6. Do not place concrete in supporting elements until the concrete previously placed in columns and walls is no longer plastic.

E. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment so the concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground, as specified for formed concrete structures. Consolidate concrete in the remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other acceptable methods. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.
4. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.



5. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

F. Bonding

1. Roughen surfaces of set concrete at all joints except where bonding is obtained by use of concrete bonding agent, and clean surfaces of laitance, coatings, loose particles and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and not to leave laitance, loose particles of aggregate or damaged concrete at the surface.
2. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
  - a. At joints between footings and walls or columns, and between walls or columns and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.
  - b. At joints in exposed work; at vertical joints in walls; at joints in girders, beams, supported slabs and other structural members; and at joints designed to contain liquids; dampen, but do not saturate the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.
  - c. Use neat cement grout consisting of equal parts Portland cement and fine aggregate by weight and not more than 6 gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16-inch. Deposit fresh concrete before cement grout has attained its initial set.
  - d. In lieu of neat cement grout, bonding grout may be a commercial bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the Bonding Material Manufacturer.
3. Prepare for bonding of fresh concrete to fully cured hardened concrete or existing concrete by using an epoxy-resin-bonding agent as follows:
  - a. Handle and store epoxy-resin adhesive binder in compliance with the Manufacturer's printed instructions, including safety precautions.
  - b. Mix the epoxy-resin adhesive binder in the proportions recommended by the Manufacturer, carefully following directions for safety of personnel.
  - c. Before depositing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy-resin grout not less than 1/16-inch thick. Place fresh concrete while the epoxy-resin material is still tacky, without

removing the in-place grout coat, and as directed by the Epoxy-resin Manufacturer.

G. Cold Weather Placing

1. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
2. Concrete may be placed when the air temperature in the shade is 40 degrees F and rising.
3. When the air temperature has fallen to or is expected to fall below 40 degrees F, provide adequate means to maintain the temperature in the area where concrete is being placed at either 70 degrees F for 3 days or 50 degrees F for 5 days after placing. Provide temporary housing or coverings including tarpaulins or plastic film. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. Keep concrete moist. Avoid rapid dry-out of concrete due to over-heating and avoid thermal shock due to sudden cooling or heating.
4. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 60 degrees F, and not more than 90 degrees F, at point of placement.
5. No concrete shall be placed, regardless of the present temperature, when the weather forecast promises freezing weather before final set of the concrete unless special means of heating and protection are used.
6. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.
7. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

H. Hot Weather Placing

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled or chopped ice may be

used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.

3. Cover reinforcing steel with water-soaked burlap if it becomes too hot so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
4. Wet forms thoroughly before placing concrete.
5. Do not use retarding admixtures unless otherwise accepted in mix designs.

### 3.7 FINISH OF FORMED SURFACES

#### A. Rough Form Finish

For formed concrete surfaces not exposed to view in the finish work or covered by other construction, unless otherwise shown or specified. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.

#### B. Smooth Form Finish

Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view. Or that are to be covered with a coating material applied directly to the concrete, or a covering material bonded to the concrete such as waterproofing, damp proofing, painting or other similar system.

Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.

#### C. Curb Finishes

Curbs shall be screeded off accurately to true lines and planes or warped surfaces as indicated or directed. Finish smooth. Arises shall be true and straight or properly eased where curved and neatly rounded with approved tool. Smooth trowel finish with corners rounded to 3/4-inch radius.

#### D. Grout Cleaned Finish (Sacked)

Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment, and to all exposed to view interior and exterior building surfaces, typical.

Combine one part Portland cement to 1-1/2 parts fine sand by volume, and mix with water to the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

Thoroughly wet concrete surfaces and apply grout immediately to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces

At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

### 3.8 MONOLITHIC SLAB FINISHES

A. Float Finish

1. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing or sand bed terrazzo, and as otherwise shown on drawings or in schedules.
2. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4-inch in 10 feet when tested with a 10-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill at low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

B. Trowel Finish

1. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, paint, or other thin-film finish coating system.
2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.

3. Consolidate the concrete surface by the final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in 10 feet when tested with a 10-foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.
- C. Exposed Aggregate Finish
1. Screed to true plane, bullfloat surfaces, provide uniform double troweled finish. After troweling, let set until hard enough to wash without disturbing coarse aggregates. Simultaneously brush and spray with water to expose large aggregate and produce texture to match approved sample. Water cure or keep wet for 25 hours.
  2. Scrub surface after 24 hours with a 1-part muriatic acid to 10-part water solution. Rinse thoroughly.
- D. Broom Finish (Non-Slip)
1. Apply non-slip, broom finish to exterior concrete platforms, steps and ramps and elsewhere as shown on the drawings or in schedules.
  2. Immediately after trowel finish, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or in the direction of water flow. Use fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the Engineer before application.
- E. Chemical-Hardener Finish
1. Apply chemical curing-hardening compound or chemical-hardener to all interior concrete floors which will not receive applied finish materials. Mask adjacent work and surfaces to avoid over spray. Apply liquid chemical-hardener after complete curing and drying of the concrete surface.
  2. Dilute the liquid hardener with water and apply in accordance with the Manufacturer's printed directions. Evenly apply each coat and allow for drying between coats in accordance with Manufacturer's printed directions.
  3. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.
- F. Non-slip Aggregate Finish
- Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, and elsewhere as shown on the drawings or in schedules.

After completion of float finishing and before starting trowel finish, uniformly spread 25 pounds of dampened non-slip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using steel trowel, but do not force the non-slip aggregate particles below surface. After broadcasting and tamping, apply trowel finish as herein specified. After curing, lightly work the surface with a steel wire brush, or an abrasive stone, and water to expose the non-slip aggregate.

### 3.9 CONCRETE CURING AND PROTECTION

#### A. General

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
2. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.
3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

#### B. Curing Methods

Perform curing of concrete by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof, as herein specified. Provide the curing methods indicated as follows:

1. For concrete floor slabs provide moisture curing, moisture cover curing, or liquid membrane/chemical curing-hardening curing. If liquid membrane curing is used, it must be compatible with concrete hardening compounds to be applied later.
2. For other concrete work, provide moisture curing or moisture cover curing. Do not use liquid membrane or chemical curing-hardening curing on any concrete work to receive any applied finishes.
3. For curing, use only water that is free of impurities, which could etch or discolor exposed, natural concrete surfaces.
4. Provide moisture curing by any of the following methods:
  - a. Keeping the surface of the concrete continuously wet by covering with water.
  - b. Continuous water-fog spray.

- c. Covering the concrete surface with the specified absorptive cover thoroughly saturated with water and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges with a 4-inch lap over adjacent absorptive covers.
5. Provide moisture-cover curing as follows - Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete placed in the widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
6. Provide liquid membrane curing as follows:
  - a. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a coat continuous operation by power spray equipment in accordance with the Manufacturer's directions. Recoat areas, which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.
  - b. Do not use membrane-curing compounds on surfaces, which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete. Such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the Engineer.
7. Curing Formed Surfaces - Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs, and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
8. Curing Unformed Surfaces
  - a. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing, whenever possible.
  - b. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.
  - c. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise acceptable to the Engineer.
9. Provide liquid curing-hardening compound as follows:

- a. Apply to horizontal surfaces when concrete is dry to touch by means of power spray, hand spray or hair broom in accordance with Manufacturer's directions.

C. Temperature of Concrete during Curing

1. When the atmospheric temperature is 40 degrees F and below, maintain the concrete temperature between 50 degrees F and 70 degrees F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulation, or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.
2. When the atmospheric temperature is 80 degrees F, and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protections complying with the requirements of ACI 305.
3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete, which exceed 5 degrees F in any 1-hour and 50 degrees F in any 24-hour period.

- D. Protection from Mechanical Injury - During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling-In - Fill-in holes and openings in concrete structures for the passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.
- B. Curbs - Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations - Provide machine and equipment bases and foundations as shown on the drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the Manufacturer furnishing the machines and equipment.



### 3.11 REMOVAL OF SHORES AND FORMS

- A. Remove shores and re-shore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate re-shoring to safely support the work without excessive stress or deflection.

Keep re-shores in place a minimum of 15 days after placing upper tier, and longer if required, until the concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

- B. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulative curing at not less than 50 degrees F for 24 hours after placing concrete. Providing the concrete is sufficiently hard to not be damaged by form removal operations and provided curing and protection operations are maintained.
- C. Formwork supporting weight of concrete, such as beam soffits, joints, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in place concrete by testing field-cured specimens representative of concrete location or members.
- D. Form facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.
- E. Re-Use of Forms

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Architect.

No forming material will be allowed to be built permanently into exposed visible surfaces.

### 3.12 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas

1. Repair and patch defective areas with cement mortar immediately after removal of forms but only when directed by the Engineer.
  2. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter, and holes left by tie rods and bolts down to solid concrete but, in no case, to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Engineer.
  3. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.
  4. Fill holes extending through concrete by means of a plunger type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.
- B. Repair of Formed Surfaces
1. Repair exposed-to-view formed concrete surfaces that contain defects, which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolt; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.
  2. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01-inch wide, cracks or any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.
- C. Repair of Unformed Surfaces
1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
3. Repair finished unformed surfaces that contain defects, which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, pop outs, honeycomb, rock pockets, and other objectionable conditions.
4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so those repairs can be made without damage to adjacent areas.
5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Engineer.
6. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating, or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same material to provide concrete of the same type or class as the original adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
7. Repair isolated random cracks and single holes not over 1-inch in diameter by the dry-pack method. Groove the top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
8. For repair of existing unformed surfaces, mechanically remove all loose concrete as required to expose sound aggregate. Clean concrete surfaces to achieve a contaminate free, open textured surface. Square cut or undercut perimeter to minimum depth as specified by the Repair Mortar Manufacturer. Remove all loose concrete around the exposed steel and hand tool or blast clean all portions of rebar with visible rust to near white metal finish. If half of the diameter of the reinforcing

steel is exposed, chip out behind the reinforcing to a 1/2-inch minimum depth. Splice new reinforcing steel to existing where corrosion has depleted the cross-section area by 25 percent. Apply a corrosion inhibitor/primer/bonding agent to all exposed rebar and other steel components and to concrete surfaces to be repaired per Manufacturer's requirements, such as Sika Armatec 110. Apply a polymer-modified, cement-based, repair mortar, trowel applied as specified by the Manufacturer, such as Sika MonoTop 615.

9. Repair methods not specified above may be used subject to the acceptance of the Engineer.

### 3.13 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. The Contractor shall engage a special inspector/testing laboratory to perform all tests and to submit test reports to the Engineer and the Owner.
- B. Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:
  1. Sampling Fresh Concrete - Secure composite samples in accordance with AASHTO T141; mold and cure specimens from each sample in accordance with AASTHO T23.
  2. Slump - ASTM 143 (AASHTO 119); one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
  3. Air Content – ASTM C231 (AASHTO T152), pressure method; one for each set of compressive strength test specimens.
  4. Concrete Temperature - Test hourly when air temperature is 40 degrees F and below, and when 80 degrees F and above; and each time a set of compression test specimens is made.
  5. Compressive Strength Tests – AASHTO T23; one test series shall be taken per 50 cubic yards (or fraction thereof) of the concrete placed per day;
    - a. Field cured test series: four (4) cylinders, one (1) to be broken at seven (7) days.
    - b. Lab cured test series: four (4) cylinders one (1) to be broken at seven (7) days; two (2) to be broken at 28 days. One (1) to be held for 56 day break should the 28 day breaks fail.
    - c. When the frequency of testing will provide less than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

- d. When the total quantity of a given class of concrete is less than 50 cubic yards, the strength tests may be waived by the Engineer if, in the Engineer's judgment, adequate evidence of satisfactory strength is provided.
- C. Report test results in writing to the Engineer and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of Contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Additional tests - The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Engineer. The testing service shall conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

END OF SECTION

## SECTION 04 20 00 – UNIT MASONRY

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SECTION INCLUDES

- A. Concrete block.
- B. Reinforcement and anchorage.
- C. Flashings.
- D. Accessories.
- E. Related Sections
  - 1. Section 04 05 13 – Masonry Mortar and Grout
  - 2. Section 07 19 00 – Water Repellants: Graffiti Coating
  - 3. Section 07 92 00 – Joint Sealants: Sealing control and expansion joints.

#### 1.3 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
- C. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire 2019.
- D. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement 2016, with Editorial Revision (2018).
- E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
- F. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units 2021.
- G. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units 2021.
- H. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry 2020.

- I. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength 2019.
- J. ASTM C1148 - Standard Test Method for Measuring the Drying Shrinkage of Masonry Mortar 1992a (Reapproved 2014).
- K. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms 2018.
- L. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry 2014a.
- M. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.

#### 1.4 SUBMITTALS

- A. See Section 01 33 00 Submittal Procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and masonry accessories.
- C. Shop Drawings: Submit reinforcing steel shop drawings.
- D. Samples: Submit four samples of field units to illustrate color, texture, and extremes of color range.
- E. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- F. Manufacturer's Certificate: Certify that Water Repellent Admixture Manufacturer has certified Masonry Unit Manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
- G. Test Reports: Concrete Masonry Manufacturer's test reports for units with integral water repellent admixture.
- H. Manufacturer's Qualification Statement.
- I. Installer's Qualification Statement.

#### 1.5 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of experience.

#### 1.6 MOCK-UP

- A. Prior to constructing walls, construct a mock-up for approval by Architect and Owner. Construct mock-up 4'-0" high and 4'-0" wide with one 90 degree corner to illustrate mortar

color, extremes of masonry color and texture ranges, and mortar jointing work. Mock-up shall include all accessories for flashing, reinforcement, insulation, weep holes, etc. to demonstrate the complete construction of the wall. Leave mock-up in place until masonry Work is completed and accepted by Architect and Owner to insure minimum deviation from the sample panel. Construct with wall surfaces facing south and east.

- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
- B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

### PART 2 PRODUCTS

#### 2.1 CONCRETE MASONRY UNITS

- A. Decorative Concrete Block: Comply with referenced standards and as follows:
  - 1. Provide units with integral water repellent
  - 2. Size: Standard units with nominal face dimensions of 16 by 8-inches and nominal depth of 8-inches.
  - 3. Special Shapes: Provide non-standard blocks configured for corners.
  - 4. Load-Bearing Units: ASTM C90, normal weight.  $F'm = 1900$  psi (Average net area compressive strength)
    - a. Exposed Faces: Refer to drawings for colors and textures.
    - b. Texture: Split face and smooth face. Refer to drawings for locations.
    - c. Manufacturers:



- 1) Basalite Concrete Products
  - 2) No Substitutions
5. Units with Integral Water Repellent: Concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at the time of manufacture.
- a. Performance of Units with Integral Water Repellent:
    - 1) Water Permeance: When tested per ASTM E514/E514M and for a minimum of 72-hours.
      - a) No water visible on back of wall above flashing at the end of 24-hours.
      - b) No flow of water from flashing equal to or greater than 0.032-gallons per hour at the end of 24-hours.
      - c) No more than twenty-five (25) percent of wall area above flashing visibly damp at end of test.
    - 2) Flexural Bond Strength: ASTM C1072; minimum ten (10) percent increase.
    - 3) Compressive Strength: ASTM C1314; maximum five (5) percent decrease.
    - 4) Drying Shrinkage: ASTM C1148; maximum five (5) percent increase in shrinkage.
  - b. Use only in combination with mortar that also has integral water repellent admixture.
  - c. Use water repellent admixtures for masonry units and mortar by a single manufacturer.

## 2.2 MASONRY LINTELS

- A. Masonry Lintels: Built-in-place masonry lintels made from U-shaped lintel block and bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

## 2.3 MORTAR AND GROUT MATERIALS

- A. Mortar and Grout: As specified in Section 04 05 11 – Masonry Mortar and Grout.

## 2.4 REINFORCEMENT AND ANCHORAGE

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; galvanized.
- B. Single Wythe Joint Reinforcement: ASTM A951/A951M.
  1. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
  2. Size: as indicated on drawings.

- C. Strap Anchors: Bent steel shapes, 1-1/2-inch width, 0.105-inch thick, 24-inch length, with 1-1/2-inch long, 90-degree bend at each end to form a U or Z shape or with cross pins, hot dip galvanized to ASTM A153/A153M Class B.
- D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8-inch of mortar coverage from masonry face.

## 2.5 MASONRY CELL-FILL

- A. Loose- Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

## 2.6 EMBEDDED FLASHING MATERIALS

- A. Single- Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.
  - 1. Mortar Net Block Flash System
  - 2. No Substitutions.

## 2.7 CLEANING MATERIALS

- A. ProSoCo "Sure-Klean 600", "101", or "Vana Trol" as suited to surfaces and conditions and other types as recommended and necessary to clean particular stains or surfaces for natural colored CMU. Product shall be approved by masonry manufacturer.

# PART 3 EXECUTION

## 3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

## 3.2 PREPARATION

## 3.3 COLD AND HOT WEATHER REQUIREMENTS

- A. Cold Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 1. Maintain materials and surrounding air temperature to minimum 40-degrees F prior to, during, and 48-hours after completion of masonry work.

- B. Hot Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 1. Maintain materials and surrounding air temperature to maximum 90-degrees F prior to, during, and 48-hours after completion of masonry work.

### 3.4 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
  - 1. Bond: Running.
  - 2. Coursing: One unit and one mortar joint to equal 8 inches. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
  - 3. Mortar Joints: Concave.

### 3.5 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high-pressure cleaning methods.
- F. Interlock intersections and external corners, except for units laid in stack bond.
- G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- I. Do not apply floor or roof loads for at least three days after building masonry walls or columns.
- J. Fill space between steel door frames and masonry solidly with mortar unless otherwise indicated.

### 3.6 REINFORCEMENT AND ANCHORAGE – SINGLE WYTHE MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16-inches on center.
- B. Place continuous joint reinforcement in first and second joint below top of walls.
- C. Lap joint reinforcement ends minimum 27-inches.
- D. Embed anchors in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36-inches horizontally and 24-inches vertically.
- E. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36-inches horizontally and 24-inches vertically.
- F. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2-inches with at least 5/8-inch mortar cover to the outside face of the anchor.

### 3.7 GROUTED COMPONENTS

- A. Lap splice reinforcing bars as indicated on structural drawings.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2-inch of dimensioned position.
- C. Place and consolidate grout fill without displacing reinforcing.

### 3.8 LINTELS

- A. Provide concrete or masonry lintels where shown and where openings of more than 16 inches for block-size units shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

### 3.9 FLASHING

- A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

### 3.10 TOLERANCE

- A. Install masonry within the site tolerances found in TMS 402/602.

### 3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 45 29 - Laboratory Testing Services Provided by Owner.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for compliance with requirements of this specification.

- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

### 3.12 CLEANING

- A. Remove excess mortar and mortar droppings as work progresses.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

### 3.13 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

## SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Structural shapes.
  - 2. Channels and angles.
  - 3. Hollow structural sections.
  - 4. Structural pipe.
  - 5. Structural plates
  - 6. Floor plates.
  - 7. Bolts, connectors, and anchors.
  - 8. Grout.

#### 1.2 RELATED SECTIONS:

- A. Section 03 60 00 - Grouting: Grout for setting base plates.
- B. Section 05 31 23 - Steel Roof Decking: Support framing for small openings in roof deck.
- C. Section 07 81 00 - Applied Fireproofing: Fireproof protection to framing and metal deck systems.

#### 1.3 UNIT PRICE – MEASUREMENT AND PAYMENT

- A. Section 01 20 00 - Price and Payment Procedures: Contract Sum/Price modification procedures.
- B. Structural Steel Framing:
  - 1. Basis of Measurement: By the ton
  - 2. Basis of Payment: Includes structural members fabricated, installed, and anchored.

#### 1.4 REFERENCE STANDARDS

- A. American Institute of Steel Construction:
  - 1. AISC 303 - Code of Standard Practice for Structural Steel Buildings and Bridges.
  - 2. AISC 341 - Seismic Provisions for Structural Steel Buildings.
  - 3. AISC 360 - Specification for Structural Steel Buildings.

- B. American Society of Civil Engineers:
  - 1. ASCE 19 - Structural Applications of Steel Cables for Buildings.
- C. American Welding Society:
  - 1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
  - 2. AWS D1.1 - Structural Welding Code - Steel.
  - 3. AWS D1.1M - Structural Welding Code - Steel.
- D. ASTM International:
  - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
  - 2. ASTM A36M - Standard Specification for Carbon Structural Steel.
  - 3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 4. ASTM A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 5. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
  - 6. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 7. ASTM A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 8. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
  - 9. ASTM A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
  - 10. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
  - 11. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  - 12. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength.
  - 13. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
  - 14. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.

15. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
16. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints.
17. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
18. ASTM A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
19. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
20. ASTM A514 - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
21. ASTM A514M - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
22. ASTM A529 - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
23. ASTM A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
24. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
25. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts.
26. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
27. ASTM A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
28. ASTM A588 - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance.
29. ASTM A588M - Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance.
30. ASTM A618 - Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
31. ASTM A618M - Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
32. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.



33. ASTM A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
34. ASTM A786 - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
35. ASTM A786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
36. ASTM A847 - Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
37. ASTM A847M - Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
38. ASTM A913 - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process.
39. ASTM A913M - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process.
40. ASTM A992 - Standard Specification for Structural Steel Shapes.
41. ASTM A992M - Standard Specification for Structural Steel Shapes.
42. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
43. ASTM E94 - Standard Guide for Radiographic Examination.
44. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments.
45. ASTM E165 - Standard Practice for Liquid Penetrant Examination for General Industry.
46. ASTM E165M - Standard Practice for Liquid Penetrant Examination for General Industry.
47. ASTM E709 - Standard Guide for Magnetic Particle Testing.
48. ASTM F436 - Standard Specification for Hardened Steel Washers.
49. ASTM F436M - Standard Specification for Hardened Steel Washers.
50. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
51. ASTM F959M - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
52. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
53. ASTM F1852 - Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

- 54. ASTM F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
- E. Green Seal:
  - 1. GC-03[- 2nd Edition, January 7, 1997] - Anti-Corrosive Paints.
- F. Research Council on Structural Connections:
  - 1. RCSC - Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- G. SSPC: The Society for Protective Coatings:
  - 1. SSPC - Steel Structures Painting Manual.
  - 2. SSPC Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
  - 3. SSPC Paint 20 - Zinc-Rich Coating (Type I - Inorganic and Type II - Organic).
  - 4. SSPC SP 3 - Power Tool Cleaning.
  - 5. SSPC SP 6 - Commercial Blast Cleaning.
  - 6. SSPC SP 10 - Near-White Blast Cleaning.

#### 1.5 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate Work of this Section with following:
  - 1. Section 05 31 23 - Steel Roof Decking for framed openings other than structural steel.
  - 2. Section 05 50 00 - Metal Fabrications for miscellaneous steel supports other than structural steel.
  - 3. Section 07 81 00 - Applied Fireproofing for finishes on structural steel receiving fireproofing.

#### 1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings:
  - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and bolts.
  - 2. Connections
  - 3. .
  - 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- E. Mill Test Reports: Submit indicating structural strength, destructive and non-destructive test analysis.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
  - 1. Submit qualifications for fabricator, erector, shop painter, and welders.

#### 1.7 QUALITY ASSURANCE

- A. Perform Work according to following:
  - 1. Structural Steel: AISC 303 and AISC 360.
  - 2. Architecturally Exposed Structural Steel: AISC 303, Section 10.
  - 3. High-Strength Bolted Connections: RCSC - Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts.
- B. Maintain copies of each standard affecting the Work of this Section on-Site.

#### 1.8 QUALIFICATIONS

- A. Fabricator:
  - 1. Company specializing in fabricating products specified in this Section with minimum three years' experience with following current AISC Certification:
    - a. Standard Steel Building Structures (STD).
    - b. Conventional Steel Building Structures (SBD).
- B. Erector:
  - 1. Company specializing in performing Work of this Section with minimum three years' experience with following current AISC Certification:
    - a. Certified Steel Erector (CSE).
    - b. Advanced Certified Steel Erector (ACSE).
- C. Shop Painter:
  - 1. Company specializing in performing Work of this Section with minimum three years' experience with following current AISC Certification:

- a. Sophisticated Paint Endorsement - Enclosed (P1).
  - b. Sophisticated Paint Endorsement - Covered (P2).
  - c. Sophisticated Paint Endorsement - Outside (P3).
- D. Welders and Welding Procedures: AWS D1.1 qualified within previous 12 months.

## PART 2 PRODUCTS

### 2.1 STRUCTURAL STEEL

- A. Structural W-Shapes: ASTM A992
- B. Round, Hollow Structural Sections: ASTM A500 , Grade B
- C. Rectangular, Hollow Structural Sections: ASTM A500, Grade [B] [C].

### 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Bolts: Heavy-hex, structural type.
  - 1. ASTM A325; Type 1,
- B. Nuts: ASTM A563; Grade <\_\_\_\_\_>; heavy-hex type.
- C. Finish: Plain Washers:
  - 1. ASTM F436.
  - 2. Type 1, [circular] [beveled].
- D. Anchor Rods:
  - 1. ASTM F1554; Grade 55, weldable

### 2.3 WELDING MATERIALS

- A. Welding Materials:
  - 1. AWS D1.1 .
  - 2. Type required for materials being welded.

### 2.4 FABRICATION

- A. Fabricate connections for bolt, nut, and washer connectors.
- B. Develop required camber for members.

### 2.5 FINISHES

- A. Prepare structural component surfaces according to SSPC SP 3.

## 2.6 SHOP-PRIME STRUCTURAL STEEL MEMBERS. ACCESSORIES

### A. Grout:

1. Non-shrink type; premixed compound consisting of nonmetallic aggregate, cement, water-reducing, and plasticizing additives.
2. Capable of developing minimum compressive strength of 7,000 <\_\_\_\_\_> psi at 28 days.
3. <\_\_\_\_\_>, manufactured by <\_\_\_\_\_>.

### B. Shop Primer: SSPC Paint 15, Type 1, red oxide.

## 2.7 SOURCE QUALITY CONTROL

### A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

### B. Testing: Test bolted and welded connections as specified in PART 3 for field quality control tests.

### C. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

## PART 3 EXECUTION

### 3.1 EXAMINATION

#### A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

#### B. Verify that bearing surfaces are at correct elevation.

#### C. Verify that anchor rods are set in correct locations and arrangements, with correct exposure for steel attachment.

### 3.2 PREPARATION

#### A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

#### B. Furnish templates for installation of anchor rods and embedments in concrete and masonry work.

### 3.3 ERECTION

#### A. Allow for erection loads and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

#### B. Field-weld components as indicated on Drawings

- C. Field-connect members with threaded fasteners; torque to required resistance and snug-tighten for bearing-type connections.
- D. Do not field-cut or alter structural members without approval of Architect/Engineer.
- E. After erection, touch up welds and abrasions to match shop finishes.

#### 3.4 GROUT INSTALLATION

- A. Grout under base plates as indicated on the drawings<
- B. Shim bearing plates and equipment supports to proper elevation, and snug-tighten anchor bolts.
- C. Fill void under bearing surface with grout; install and pack grout to remove air pockets.
- D. Moist-cure grout.
- E. Remove forms after grout is set; trim grout edges to form smooth surface, splayed 45 degrees.
- F. Tighten anchor bolts after grout has cured for a minimum of three days.

#### 3.5 TOLERANCES

- A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.
- B. Maximum Variation from Plumb: 1/4inch
- C. Maximum Offset from Alignment: 1/4 inch

#### 3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
- B. Bolted Connections: Inspect according to AISC 303.
  - 1. Visually inspect all bolted connections.
  - 2. Direct Tension Indicators: Comply with requirements of ASTM F959, and verify that gaps are less than gaps specified in Table 2.
- C. Welding: Inspect welds according to AWS D1.1 .
  - 1. Use certified welders, and conduct inspections and tests as required. Record types and locations of defects found in Work. Record work required and performed to correct deficiencies.
- D. Correct defective bolted connections and welds.

END OF SECTION

## SECTION 05 31 23 - STEEL ROOF DECKING

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Steel roof deck and accessories.
2. Formed steel cant strips, eave strips,
3. Framing for openings up to and including 18 inches
4. Bearing plates and angles.

B. Related Sections:

1. Section 05 12 00 - Structural Steel Framing: Support framing for deck openings.
2. Section 07 27 00 - Air Barriers.

#### 1.2 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Baked Hardenable.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

C. Steel Deck Institute:

1. SDI 29 - Design Manual for Composite Decks, Form Decks and Roof Decks.

D. SSPC: The Society for Protective Coatings:

1. SSPC Paint 15 - Steel Joist Shop Paint.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Design metal deck in accordance with SDI 29 Design Manual and ASCE 3.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal requirements.
- B. Shop Drawings: Indicate deck plan, support locations, Projections, openings and reinforcement, pertinent details, and accessories.
- C. Product Data: Submit deck profile characteristics and dimensions, structural properties, finishes.
- D. Manufacturer's Installation Instructions: Submit Manufacturer's installation instructions.
- E. Manufacturer's Certificates: Certify Products meet or exceed specified requirements.
- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

#### 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with
- B. Maintain one copy of eac document on site.

#### 1.6 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Cut plastic wrap to encourage ventilation.
- C. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with [G90] ([Z275]) galvanized coating
- B. Bearing [Plates] [Angles]: ASTM A36/A36M steel,
- C. Welding Materials: AWS D1.1.
- D. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 [Type I Inorganic] [Type II Organic].

#### 2.2 ACCESSORIES

- A. Eave Strips: Fabricated of metal of same type and finish as deck.



## 2.3 FABRICATION

- A. Metal Deck: Sheet steel, configured as follows:
  - 1. Span Design: multiple
  - 2. Minimum Metal Thickness Excluding Finish: 20 gauge.
  - 3. Minimum Section Properties (per foot width): As indicated on the drawings. Nominal Height: 1-1/2 fluted profile to SDI [NR] [IR] [WR].
  - 4. Formed Sheet Width: [24] [32] inch.
  - 5. Side Joints: As indicated on the drawings.
- B. Related Deck Accessories: Metal closure strips, cant strips, [20] gauge
- C. Cant Strips: Formed sheet steel, <\_\_\_\_\_> gauge thick, 45 degree slope, 3 1/2 inch (nominal width and height, flange for attachment).

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

### 3.2 INSTALLATION

- A. Erect metal deck in accordance with SDI Manual.
- B. Bear deck on masonry support surfaces with bearing as indicated on the drawings.. Align and level.
- C. Bear deck on steel supports with full bearing on beam flanges. Align and level.
- D. Fasten ribbed deck to steel support members at ends and intermediate supports with fusion welds through weld washers as indicated on the drawings
- E. Weld in accordance with AWS D1.1.
- F. Seal deck joints, laps, ends, and penetrations with sealant to achieve permanent air seal consistent with air barrier system specified in Section 07 27 00.
- G. Reinforce steel deck Openings as indicated on the drawings.
- H. Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings.
- I. Install [single] [double] row of foam flute closures [above walls and partitions perpendicular to deck flutes].
- J. Place metal cant strips in position and [fusion weld.] [mechanically attach.]

- K. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up prime paint.

### 3.3 FIELD QUALITY CONTROL

- A. Welding: Inspect welds in accordance with AWS D1.1.

END OF SECTION

## SECTION 07 19 00 - WATER REPELLENTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes penetrating water and graffiti repellent treatments for the following vertical and horizontal surfaces:

- 1. Concrete unit masonry.

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. Test Area: Test a minimum 4 ft. by 4 ft. area on each type of masonry. Use the manufacturer's application instructions. Let test area protective treatment cure before inspection. Keep test panels available for comparison throughout the protective treatment project.

### PART 2 - PRODUCTS

#### 2.1 PENETRATING WATER & GRAFFITI REPELLENTS

- A. Basis-of-Design: Prosoco Sure Klean® Weather Seal Blok-Guard® & Graffiti Control Ultra.
  - 1. A clear, solvent-based silicone elastomer formulated to weatherproof concrete block and other porous masonry materials and protect treated surfaces from repeated graffiti attacks without altering the natural appearance.
  - 2. Technical Product Data:
    - a. Form: Clear liquid.
    - b. Active Content: 9 percent.
    - c. Total Solids: 9 percent ASTM D 2369.

- d. Flash Point: 100 degrees F (38 degrees C) ASTM D 3278.
- e. Freeze Point: less than -22 degrees F (less than -30 degrees C).
- f. VOC Content: 100 g/L, maximum.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
  - 1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in representative locations by method recommended by manufacturer.
  - 2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
  - 3. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

### 3.2 PREPARATION

- A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.
- B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.
- C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.
- D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
  - 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

### 3.3 APPLICATION

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

- B. Apply coating of water repellent on surfaces to be treated using low-pressure spray to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
  - 1. Using low-pressure (<50 psi) spray equipment, saturate, "wet-on-wet" from the bottom up. Avoid excessive overlapping.
  - 2. Let the first application penetrate the masonry surface for 2 to 3 minutes. For heavily textured and porous surfaces, reapply in same saturating manner to ensure complete coverage of recessed surfaces.
  - 3. Immediately brush out runs and drips to prevent build up.
- C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.
- D. Protect treated surfaces from rain for 4-6 hours or as recommended by manufacturer.

#### 3.4 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application.
- B. Comply with manufacturer's written cleaning instructions.

END OF SECTION

## SECTION 07 21 00 - THERMAL INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Polyisocyanurate foam-plastic board insulation (Roof).

### PART 2 - PRODUCTS

#### 2.1 FOAM-PLASTIC BOARD INSULATION

##### A. General: Products shall meet Colorado Greenhouse Gas Regulations 5 CCR 1001-26 regulating prohibited blowing agents for foam insulation products.

1. Prohibited blowing agents (refer to full regulation for specific product requirements).

- a. HFC-134a
- b. HFC-143a
- c. HFC-245fa
- d. HFC-365mfc
- e. Formacel B
- f. Formacel TI
- g. Formacel Z-6

##### B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 felt or glass-fiber mat facer on both major surfaces.

#### 2.2 INSULATION FASTENERS

##### A. Adhesively Attached, Spindle Type Anchors: Plate and angle formed from perforated galvanized carbon steel sheet, 0.030 inch thick by 2 inches square, welded to projecting copper coated steel spindle 0.105 inch in diameter and enough length capable of holding insulation of thickness indicated securely in position with 1-1/2" square or diameter self-locking washers complying with the following requirements.

1. Installation Retaining Washers: Self-locking washers formed from 0.016 inch thick galvanized steel sheet, with beveled edge for increased stiffness.
2. Where anchors are located in ceiling plenums or attic spaces, protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.

- B. Installation Standoff: Spacer fabricated from galvanized mild steel sheet for fitting over spindle of insulation anchor to maintain air space of two inches between face of insulation and substrate to which anchor is attached.
- C. Anchor Adhesive: Product with demonstrate capability to bond insulation anchors securely to substrates indicated without damaging insulation fasteners and substrates.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

#### 3.2 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Foam Plastic Board Insulation: Seal joints between units by applying adhesive, mastic or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed insulation with adhesive, mastic or sealant as recommended by the insulation manufacturer.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation.

END OF SECTION

## SECTION 07 41 13 - STANDING-SEAM METAL ROOF PANELS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes standing-seam metal roof panels, underlayment, cover board and accessories.

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of metal panel indicated.
- D. Product test reports.
- E. Warranties: Sample of special warranties.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.



- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
  - 1. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 1680 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
  - 1. Uplift Rating: UL 90.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips inside laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
  2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide UC-4 Panel manufactured by Holcim Elevate (formerly Firestone) or comparable product by one of the following:
    - a. AEP Span
    - b. Berridge
    - c. Drexel Metals, Inc.
    - d. Petersen Aluminum Corporation
  2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
    - a. Nominal Thickness: 24 gage (0.61 mm).
    - b. Exterior Finish: Two-coat fluoropolymer.
    - c. Color: To be selected from manufacturer's full range.
  3. Clips: One-piece or two-piece fixed to accommodate thermal movement.
    - a. Material: 0.064-inch- (1.63-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
  4. Joint Type: As standard with manufacturer.
  5. Panel Coverage: 18 inches with intermediate pencil rib panel striations.
  6. Panel Height: 1.5 inches.

## 2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
  2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
  3. Products: Subject to compliance with requirements, provide one of the following:
    - a. Carlisle Construction Materials; WIP 300HT.
    - b. Drexel Metals, Inc.; MetShield.
    - c. Grace Construction Products, a unit of W. R. Grace & Co.; Grace Ultra.
    - d. Metal-Fab Manufacturing, LLC; MetShield.
    - e. Owens Corning; WeatherLock Metal High Temperature Underlayment.
    - f. Tamko; TW Metal & Tile Underlayment.
    - g. Approved equal.
- B. Slip Sheet: Manufacturer's recommended slip sheet, if required, of type required for application.

## 2.4 COVER BOARDS

- A. Gypsum-Based Cover Board: Non-combustible, water resistant gypsum core with embedded glass mat facers, complying with ASTM C1177/C 1177M, and with the following additional characteristics:
1. Thickness: As indicated on drawings.
  2. Surface Water Absorption: 2.5 g, maximum, when tested in accordance with ASTM C473.
  3. Spanning Capability: Recommended by manufacturer for following minimum flute spans:
    - a. 1/4 inch (6 mm) Thickness: 2-5/8 inches (66 mm), minimum.
  4. Surface Burning Characteristics: Flame spread of 0, smoke developed of 0, when tested in accordance with ASTM E84.
  5. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
  6. Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.
  7. Mold Growth Resistance: Zero growth, when tested in accordance with ASTM D3273 for minimum of 4 weeks.
  8. Pre-primed for better adhesion.
  9. Basis-of-Design Product: Georgia-Pacific DensDeck Prime Roof Board or other board as approved by metal roofing manufacturer.

## 2.5 ROOF INSULATION

- A. See Section 072100 – Thermal Insulation for roofing insulation.

## 2.6 MISCELLANEOUS MATERIALS

- A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
  - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish shall match metal roof panels.
- D. Seamless Gutters: Formed from 0.0179-inch- (0.45-mm-) thick, metallic-coated steel sheet. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual". Furnish gutter supports spaced 36 inches (900 mm) o.c., fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match color of metal fascia panels.
- E. Downspouts: Formed from 0.0179-inch- (0.45-mm-) thick, metallic-coated steel sheet; in 10-foot- (3-m-) long sections, complete with formed elbows and offsets. Finish downspouts to match color of metal roof panels.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
  - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
  - 2. Joint Sealant: ASTM C 920; as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

## 2.7 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

## 2.8 FINISHES

- A. Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 621 Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
  - 2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

### 3.2 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges

not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

### 3.3 METAL PANEL INSTALLATION

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
  1. Install clips to supports with self-tapping fasteners.
  2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
  3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
  4. Watertight Installation:
    - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommended in writing by manufacturer as needed to make panels watertight.
    - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

### 3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

## SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Manufactured reglets and counterflashing.
2. Formed roof drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed steep-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.

#### 1.2 SUBMITTALS

##### A. Shop Drawings: Show installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.

1. Include details for forming, joining, supporting, and securing sheet metal flashing and trim, including pattern of seams, termination points, fixed points, expansion joints, expansion-joint covers, edge conditions, special conditions, and connections to adjoining work.

##### B. Samples: For each exposed product and for each finish specified.

##### C. Warranty: Sample of special warranty.

#### 1.3 QUALITY ASSURANCE

##### A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

#### 1.4 WARRANTY

##### A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.



## PART 2 - PRODUCTS

### 2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
  - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
  - 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
  - 3. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.
  - 4. Color: As selected by Architect from manufacturer's full range.

### 2.2 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
  - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
  - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).

### 2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.

- b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
  - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
- 2. Fasteners for Zinc-Coated (Galvanized) or Aluminum Zinc Alloy Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Solder:
  - 1. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.4 REGLETS

- A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.
  - 1. Material: Galvanized steel, 0.022 inch (0.56 mm) thick.
  - 2. Finish: With manufacturer's standard color coating.

## 2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
  - 1. Obtain field measurements for accurate fit before shop fabrication.
  - 2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
  - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

- B. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- C. Expansion Provisions: Where lapped or bayonet type expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

## 2.6 ROOF DRAINAGE SHEET METAL FABRICATIONS

- A. Through-Wall Overflow Scuppers: Fabricate overflow through-wall scuppers to the cross sections indicated on the drawings complete with mitered corners, flashings and drip edges.
- B. Finish: All of the through-wall scuppers on the project shall be prefinished utilizing fluoropolymer coatings.

## 2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
- B. Drip Edges: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
- C. Ridge and Edge Flashings: Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
- D. Finish: All of the gutters and downspouts on the project shall be prefinished utilizing fluoropolymer coatings.

## 2.8 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate head, sill, and similar flashings to extend 4 inches (100 mm)] beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
  - 1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.

B. Wall Expansion Joint Cover: Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

## PART 3 - EXECUTION

### 3.1 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

### 3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
  4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
  5. Install sealant tape where indicated.
  6. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.

- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal joints as shown and as required for watertight construction.

### 3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant.
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

### 3.4 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.5 CLEANING AND PROTECTION

- A. Clean and neutralize flux materials. Clean off excess solder and sealants.
- B. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

## SECTION 07 72 00 - ROOF ACCESSORIES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Roof specialties and accessories including but not limited to roof hatches and manufactured curbs, and related items as shown on the Drawings and specified herein.

#### 1.2 RELATED SECTIONS

- A. Section 074113 – Standing Seam Metal Roof Panels.
- B. Section 076200—Sheet Metal Flashing and Trim.

#### 1.3 SUBMITTALS

- A. Submit Product Data for roof hatch, roof curbs, specialties, and accessories. Include fastening methods and installation details.
- B. Submit schedule of all required curbs. Show locations, sizes, and gauge of steel of each curb being furnished.
- C. Submit the roof hatch manufacturer’s written guarantee against defects in material or workmanship.

#### 1.4 WARRANTY

- A. The roof hatch warranty shall cover a time period of 5 years after the date of final acceptance of the project.

### PART 2 PRODUCTS

#### 2.1 ROOF HATCH – EQUIPMENT ACCESS

- A. Manufacturer: Basis-of-Design Type D Roof Hatch by The BILCO Company, or approved equal by one of the following:
  - 1. Babcock-Davis
  - 2. Nystrom
- B. Furnish and install where indicated on plans metal roof hatch for equipment access, size per drawings. The roof hatch shall be double leaf. The roof hatch shall be pre-assembled from the manufacturer.
- C. Performance characteristics:

1. Covers shall be reinforced to support a minimum live load of 40 psf (195kg/m<sup>2</sup>) with a maximum deflection of 1/150th of the span or 20 psf (97 kg/m<sup>2</sup>) wind uplift.
  2. Operation of the covers shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  3. Operation of the covers shall not be affected by temperature.
  4. Entire hatch shall be weather tight with fully welded corner joints on covers and curb.
- D. Covers: Shall be 14 gauge (1.9 mm) paint bond G-90 galvanized steel with a 3" (76mm) beaded flange with formed reinforcing members. Covers shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- E. Cover insulation: Shall be fiberglass of 1" (25mm) thickness, fully covered and protected by a metal liner 22 gauge (.8mm) paint bond G-90 galvanized steel.
- F. Curb: Shall be 12" (305mm) in height and of 14 gauge paint (1.9 mm) bond G-90 galvanized steel. The curb shall be formed with a 3-1/2" (89mm) flange with 7/16" (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, with flashing system to integrate into standing seam metal roofing.
- G. Curb insulation: Shall be rigid, high-density fiberboard of 1" (25mm) thickness on outside of curb.
- H. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe through bolted to the curb assembly.
- I. Hardware
1. Heavy pintle hinges shall be provided.
  2. Covers shall be equipped with an enclosed two point spring latch with interior and exterior turn handles.
  3. Roof hatch shall be equipped with interior and exterior padlock hasps.
  4. The latch strike shall be a stamped component bolted to the curb assembly.
  5. Covers shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
  6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. [For installation in highly corrosive



environments or when prolonged exposure to hot water or steam is anticipated, specify Type 316 stainless steel hardware.

7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.

- J. Finishes: Factory finish shall be alkyd based red oxide primed steel.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install products in strict accordance with manufacturer's instructions and approved submittals. Locate units level, plumb, and in proper alignment with adjacent work.
  1. Test units for proper function and adjust until proper operation is achieved.
  2. Repair finishes damaged during installation.
  3. Restore finishes so no evidence remains of corrective work.
- C. Coordinate with installation of roofing system and related flashings.
- D. Apply backing paint on aluminum surfaces of unit in contact with cementitious or dissimilar materials.
- E. Provide weather tight installation.

END OF SECTION

## SECTION 07 92 00 - JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
  - 1. Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 2. Exterior joints in horizontal traffic surfaces.
  - 3. Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  - 4. Interior joints in horizontal traffic surfaces.
- B. See Division 8 Section "Glazing" for glazing sealants.

#### 1.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

#### 1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Color Card: For sealant color selections for each product indicated.
- C. Product certificates.

#### 1.4 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two (2) years from date of Substantial Completion.

- B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

- 1. Warranty Period: Two (2) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

### 2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### 2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- D. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant ES-1:
  - 1. Available Products:
    - a. Pecora Corporation; 898.
    - b. Tremco; Tremsil 600 White.
  - 2. Type and Grade: S (single component) and NS (nonsag).
  - 3. Class: 25.

4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

E. Multicomponent Nonsag Urethane Sealant ES-2:

1. Available Products:
  - a. Schnee-Morehead, Inc.; Permathane SM 7200.
  - b. Sika Corporation, Inc.; Sikaflex - 2c NS TG.
  - c. Sonneborn, Division of ChemRex Inc.; NP 2.
  - d. Tremco; Vulkem 227.
  - e. Tremco; Vulkem 322 DS.
2. Type and Grade: M (multicomponent) and NS (nonsag).
3. Class: 25.
4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

F. Multicomponent Pourable Urethane Sealant ES-3:

1. Available Products:
  - a. Bostik Findley; Chem-Calk 550.
  - b. Meadows, W. R., Inc.; POURTHANE.
  - c. Pacific Polymers, Inc.; Elasto-Thane 227 High Shore Type I (Self Leveling).
  - d. Pacific Polymers, Inc.; Elasto-Thane 227 Type I (Self Leveling).
  - e. Pecora Corporation; Urexpan NR-200.
  - f. Polymeric Systems Inc.; PSI-270SL.
  - g. Schnee-Morehead, Inc.; Permathane SM 7201.
  - h. Tremco; THC-901.
  - i. Tremco; THC-900.
  - j. Tremco; Vulkem 245.
  - k. Pecora Corporation; Urexpan NR 300, Type H.
  - l. Pecora Corporation; Urexpan NR 300, Type M.
2. Type and Grade: M (multicomponent) and P (pourable).
3. Class: 25.
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

## 2.4 SILICONE JOINT SEALANTS

### A. Mildew-Resistant Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. BASF Building Systems.
  - b. Dow Corning Corporation.
  - c. GE Advanced Materials - Silicones.
  - d. Pecora Corporation.
  - e. Polymeric Systems, Inc.
  - f. Sika Corporation; Construction Products Division.
2. Type: Single component (S).
3. Grade: Nonsag (NS).
4. Class: 50.
5. Uses Related to Exposure: Nontraffic (NT).

## 2.5 LATEX JOINT SEALANTS

### A. Latex Sealant LS-1: Comply with ASTM C 834, Type O P, Grade NF.

### B. Available Products:

1. Bostik Findley; Chem-Calk 600.
2. Pecora Corporation; AC-20+.
3. Schnee-Morehead, Inc.; SM 8200.
4. Sonneborn, Division of ChemRex Inc.; Sonolac.
5. Tremco; Tremflex 834.

## 2.6 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), O (open-cell material), B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

## 2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant.
    - a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
  - 2. Remove laitance and form-release agents from concrete.
    - a. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealant from surfaces adjacent to joints.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application JS-1: Exterior horizontal traffic, isolation, and contraction joints in cast-in-place concrete slabs.
  - 1. Joint Sealant: Multicomponent pourable polysulfide sealant ES-3.
- B. Joint-Sealant Application JS-2: Exterior perimeter joints between the cementitious siding and the frames of doors, windows, and louvers.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.
- C. Joint-Sealant Application JS-3: Exterior control and expansion joints in overhead surfaces.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.
- D. Joint-Sealant Application JS-4: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.
- E. Joint-Sealant Application JS-5: Interior perimeter joints of exterior openings.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.
- F. Joint-Sealant Application JS-6: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.
- G. Joint-Sealant Application JS-7: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
  - 1. Joint Sealant: Single-component mildew-resistant neutral-curing silicone sealant ES-1.
  - 2. Joint-Sealant Color: White or clear.
- H. Joint-Sealant Application JS-8: Perimeter joints between interior wall surfaces and frames of interior doors and windows.
  - 1. Joint Sealant: Latex sealant.
- I. Joint-Sealant Application JS-9: Interior control, expansion, and isolation joints in horizontal traffic surfaces of concrete slabs-on-grade.
  - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-2.

END OF SECTION



## SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Standard hollow metal doors and frames.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
- C. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amweld Building Products, LLC.
  - 2. Ceco Door Products; an Assa Abloy Group company.
  - 3. Curries Company; an Assa Abloy Group company.
  - 4. Steelcraft; an Ingersoll-Rand company.

#### 2.2 MATERIALS

- A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- B. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
  - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

- C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- D. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
- E. Insulation: Polyurethane
- F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

## 2.3 STANDARD HOLLOW METAL DOORS

- A. General: Comply with ANSI/SDI A250.8.
  - 1. Design: Flush panel.
  - 2. Core Construction: Manufacturer's standard vertical steel-stiffener and polyurethane insulated core.
    - a. Thermal-Rated (Insulated) Exterior Doors: Polyurethane insulation with U-value of not more than 0.36.
  - 3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
  - 4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
  - 5. Tolerances: SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Comply with ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
  - 1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).
  - 2. All exterior doors shall be 14 gauge metal.
  - 3. Basis-of-Design: Curries Trio 777-E, steel stiffened with polyurethane insulation; or equal.
- C. Hardware Reinforcement: ANSI/SDI A250.6.

## 2.4 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8.
- B. Exterior Frames: Fabricated from metallic-coated steel sheet.
  - 1. Fabricate frames with mitered or coped corners.
  - 2. Fabricate frames as full profile welded.
  - 3. Frames for Exterior Doors: 14 gauge metal.
- C. Hardware Reinforcement: ANSI/SDI A250.6.
  - 1. Full width hinge reinforcement, 12" long.

2. Closer reinforcement.

## 2.5 FRAME ANCHORS

### A. Jamb Anchors:

1. Masonry Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

### B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface.

## 2.6 STOPS AND MOLDINGS

### A. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

## 2.7 ACCESSORIES

### A. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

## 2.8 FABRICATION

### A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

### B. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors. Seal joints in top edges of doors against water penetration.

### C. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
  - a. Masonry Anchors: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
    - 1) Three anchors per jamb up to 60 inches (1524 mm) high.
    - 2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
    - 3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
    - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
    - 5) Two anchors per head for frames more than 42 inches (1066 mm) wide and mounted in metal-stud partitions.
  - b. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

D. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

## 2.9 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: ANSI/SDI A250.10.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    - a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    - b. Install frames with removable glazing stops located on secure side of opening.
    - c. Install door silencers in frames before grouting.
    - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    - e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    - f. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
  2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
    - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
  3. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
  4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  5. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
    - a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    - b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).

- d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

### 3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

## SECTION 08 71 00 – DOOR HARDWARE

### GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.02 SUMMARY

- A. Section includes:
  - 1. Mechanical door hardware for:
    - a. Swinging doors.
  - 2. Field verification, preparation and modification of existing doors and frames to receive new door hardware.
  - 3. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:
  - 1. Windows
  - 2. Cabinets (casework), including locks in cabinets
  - 3. Signage
  - 4. Toilet accessories
  - 5. Overhead doors
- C. Related Sections:
  - 1. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
  - 2. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.

### 1.03 REFERENCES

- A. UL - Underwriters Laboratories
  - 1. UL 305 - Panic Hardware
- B. DHI - Door and Hardware Institute
  - 1. Sequence and Format for the Hardware Schedule
  - 2. Recommended Locations for Builders Hardware
  - 3. Key Systems and Nomenclature
- C. ANSI - American National Standards Institute
  - 1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

### 1.04 SUBMITTALS

- A. General:
  - 1. Submit in accordance with Conditions of Contract and Division 01 requirements.
  - 2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
  - 3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
- B. Action Submittals:
  - 1. Product Data: Technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
  - 2. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
    - a. Door Index; include door number, heading number, and Architects hardware set number.
    - b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
    - c. Quantity, type, style, function, size, and finish of each hardware item.
    - d. Name and manufacturer of each item.
    - e. Fastenings and other pertinent information.
    - f. Location of each hardware set cross-referenced to indications on Drawings.
    - g. Explanation of all abbreviations, symbols, and codes contained in schedule.
    - h. Mounting locations for hardware.



- i. Door and frame sizes and materials.
  - j. Name and phone number for local manufacturer's representative for each product.
    - 1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.
3. Key Schedule:
- a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
  - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
  - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
  - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
  - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
    - 1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
  - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
4. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.
- C. Informational Submittals:
- 1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
  - 2. Warranty: Special warranty specified in this Section.
- D. Closeout Submittals:
- 1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
    - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    - b. Catalog pages for each product.
    - c. Factory order acknowledgement numbers (for warranty and service)
    - d. Name, address, and phone number of local representative for each manufacturer.
    - e. Parts list for each product.
    - f. Final approved hardware schedule, edited to reflect conditions as-installed.
    - g. Final keying schedule
    - h. Copies of floor plans with keying nomenclature

- i. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- j. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

## 1.05 QUALITY ASSURANCE

- A. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
  - 1. Warehousing Facilities: In Project's vicinity.
  - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
  - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
  - 4. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
    - a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- B. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
  - 1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC).
  - 2. Can provide installation and technical data to Architect and other related subcontractors.
  - 3. Can inspect and verify components are in working order upon completion of installation.
  - 4. Capable of producing wiring diagrams.
  - 5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.
- C. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
- E. Keying Conference
  - 1. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
    - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
    - b. Preliminary key system schematic diagram.

- c. Requirements for key control system.
- d. Requirements for access control.
- e. Address for delivery of keys.

F. Pre-installation Conference

- 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- 2. Inspect and discuss preparatory work performed by other trades.
- 3. Inspect and discuss electrical roughing-in for electrified door hardware.
- 4. Review sequence of operation for each type of electrified door hardware.
- 5. Review required testing, inspecting, and certifying procedures.
- 6. Conference can be done remotely via web or conference call.

G. Coordination Conferences:

- 1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

- 1. Deliver each article of hardware in manufacturer's original packaging.

C. Project Conditions:

- 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- 2. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

D. Protection and Damage:

- 1. Promptly replace products damaged during shipping.
- 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
- 3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

E. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

## 1.07 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

## 1.08 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Beginning from date of Substantial Completion, for durations indicated.
    - a. Closers:
      - 1) 10 years.
    - b. Exit Devices:
      - 1) 3 years.
    - c. Locksets & Cylinders:
      - 1) 5 years.
    - d. All other hardware
      - 1) 2 years.
  - 2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

## PRODUCTS

### 2.01 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

## 2.02 MATERIALS

### A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
  2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
  3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
  4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

## 2.03 CONTINUOUS HINGES

### A. Manufacturers and Products:

1. Acceptable Manufacturers: Stanley, Hager, Ives.

### B. Requirements:

- C. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
- D. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.

## 2.04 MORTISE LOCKS – GRADE 1

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Best Access (NO SUBSTITUTIONS)
2. Required Local Provider: Key-Rite

### B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Grade 1 with antifriction latch bolt with 1-inch throw:

2. Cylinders: Refer to "KEYING" article, herein.
3. Provide locks with standard 2-3/4 inches (70 mm) backset.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide S3 strikes, 4-7/8" high.
7. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.

## 2.05 CYLINDERS

### A. Manufacturers:

1. Scheduled Manufacturer: Best Access (NO SUBSTITUTIONS)
2. Require Local Provider: Key-Rite

### B. Requirements:

1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

### C. Construction Keying:

1. Replaceable Construction Cores.
  - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
    - 1) 3 construction control keys
    - 2) 12 construction change (day) keys.
  - b. Coordinate with Owner or Owner's Representative for replacement of temporary construction cores with permanent cores.

## 2.06 KEYING

- A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Cylinders/cores keyed into Owner's existing factory registered keying system.
- C. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- D. Requirements:
  1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
    - a. Master Keying system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
3. Provide keys with the following features:
  - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
4. Identification:
  - a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Do not provide blind code marks with actual key cuts.
  - b. Identification stamping provisions must be approved by the Architect and Owner.
  - c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
  - d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
  - e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
5. Quantity: Furnish in the following quantities.
  - a. Change (Day) Keys: 3 per cylinder/core.
  - b. Permanent Control Keys: 3.
  - c. Master Keys: 6.

## 2.07 DOOR CLOSERS

### A. Manufacturers and Products:

1. Acceptable Manufacturers: LCN, Norton, Stanley.

### B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.

7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.08 PROTECTION PLATES

### A. Manufacturers:

1. Acceptable Manufacturers: Trimco, Rockwood, Zero International.

### B. Requirements:

1. Provide kick plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes of plates:
  - a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs.
    - 1) Where kick plate is scheduled for pull side of door; provide kick plate 1 inch less width of door.

## 2.09 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

### A. Manufacturers:

1. Acceptable Manufacturers: Glynn-Johnson, Rixson, Sargent.

### B. Requirements:

1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

## 2.10 DOOR STOPS AND HOLDERS

### A. Manufacturers:

1. Acceptable Manufacturers: Ives, Rockwood, Trimco.



- B. Provide door stops at each door leaf:
  - 1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
  - 2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
  - 3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

## 2.11 THRESHOLDS, SEALS, DOOR SWEEPS, AND GASKETING

- A. Manufacturers:
  - 1. Acceptable Manufacturers: Pemko, Zero International
- B. Requirements:
  - 1. Provide thresholds, weather-stripping (including door sweeps, seals, and astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
  - 2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
  - 3. Size of thresholds:
    - a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
    - b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width
  - 4. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

## 2.12 SILENCERS

- A. Manufacturers:
  - 1. Acceptable Manufacturers: Ives, Rockwood, Trimco.
- B. Requirements:
  - 1. Provide "push-in" type silencers for hollow metal or wood frames.
  - 2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
  - 3. Omit where gasketing is specified.

## EXECUTION

### 3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
  - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
  - 2. Custom Steel Doors and Frames: HMMA 831.
  - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
  - 1. Replace construction cores with permanent cores as indicated in keying section.
- I. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- J. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- K. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- M. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- N. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- O. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.03 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

### 3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

### 3.05 DOOR HARDWARE SCHEDULE

A. Hardware items are referenced in the following hardware. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.

B. Manufacturer Abbreviations:

BE	Best Access (NO SUBSTITUTIONS)
HA	Hager
KB	Knox Box
PE	Pemko
RO	Rockwood
ST	Stanley
TR	Trimco

C. Hardware Finishes:

626	Satin Chromium Plated
630	Satin Stainless Steel
689	Aluminum Painted
Alum	Aluminum, Satin
DB	Dark Bronze Anodized Aluminum

D. Hardware Sets:

#### SET #1 – Exterior Single (Storage Function)

1	Continuous Hinge	780-210 HD x D.H.	DB	HA
1	Mortise Lockset	45H-7TD15H PATD	630	BE
1	Permanent Cylinder Core	Coordinate with Key-Rite	626	BE
1	Closer/Stop	D-4550 CS	689	ST
1	Protection Plate	KO050 24" x 2" LDW B4E CSK	630	TR
1	Latch Guard	320-RKW	630	RO
1	Weatherstrip	303DS x Head & Jambs	DB	PE
1	Door Bottom	3151DN x DW	DB	PE
1	Threshold	1715D x DW	Alum	PE

#### MISC – Fire Department Box

1	Knox Box	KLS-3274 recessed	DkBr	KB
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END OF SECTION

## SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings and soffits.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.
- B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

#### 2.2 FRAMING SYSTEMS

- A. Steel Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.
  1. Minimum Base-Metal Thickness: 0.018 inch minimum.
  2. Depth: As indicated on Drawings.
- B. Slip-Type Head Joints: Where indicated, provide one of the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
  1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.

2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
    - 2) MBA Building Supplies; Slotted Deflecto Track.
    - 3) Steel Network Inc. (The); VertiTrack VTD Series.
    - 4) Superior Metal Trim; Superior Flex Track System (SFT).
    - 5) Telling Industries; Vertical Slip Track.
- C. Firestop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
    - b. Grace Construction Products; FlameSafe FlowTrak System.
    - c. Metal-Lite, Inc.; The System.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  1. Minimum Base-Metal Thickness: 0.018 inch.
- E. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
  1. Depth: 1-1/2 inches.
  2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  1. Minimum Base-Metal Thickness: 0.033 inch.
  2. Depth: 7/8 inch.
- G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
  1. Depth: As indicated on Drawings.
  2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
  3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch-diameter wire.

## 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Hanger Attachments to Concrete:
  - 1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
    - a. Type: Postinstalled, expansion anchor.
  - 2. Powder-Actuated Fasteners: Capable of sustaining, a load equal to 10 times that imposed as determined by ASTM E 1190.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch-wide flanges.
  - 1. Depth: 2-1/2 inches.
- F. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch wide flanges, 3/4 inch deep.
  - 2. Steel Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.
    - a. Minimum Base-Metal Thickness: 0.018 inch.
    - b. Depth: As indicated on Drawings.
  - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
    - a. Minimum Base-Metal Thickness: 0.018 inch.

## 2.4 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide asphalt saturated organic felt or foam gasket.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.2 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.



3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
  6. Curved Partitions:
    - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.
- E. Direct Furring:
1. Screw to wood framing.
  2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### 3.3 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
  3. Do not attach hangers to steel roof deck.

4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  6. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

## SECTION 09 91 20 – PAINTING (PROFESSIONAL LINE PRODUCTS)

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Surface preparation and application of primer and finish coatings for all new surfaces as scheduled.

#### 1.2 RELATED SECTIONS

- A. Section 042200 – Concrete Masonry Units.
- B. Section 051200 – Structural Steel Framing.
- C. Section 053123 – Steel Roof Decking.
- D. Section 077200 – Roof Accessories.
- E. Section 081113—Hollow Metal Doors and Frames.

#### 1.3 REFERENCES

- A. ASTM D16—Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
- B. ASTM D2016—Test Method for Moisture Content of Wood.
- C. AWWA (American Water Works Association)—C204—Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping.
- D. AWWA (American Water Works Association)—D102—Painting Steel Water Storage Tanks.
- E. NACE (National Association of Corrosion Engineers)—Industrial Maintenance Painting.
- F. NPCA (National Paint and Coatings Association)—Guide to U.S. Government Paint Specifications.
- G. NSF 61—Drinking Water System Components—Health Effects.
- H. PDCA (Painting and Decorating Contractors of America)—Painting—Architectural Specifications Manual.
- I. SSPC (Steel Structures Painting Council)—Steel Structures Painting Manual.

#### 1.4 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this Section.

## 1.5 SUBMITTALS

- A. Product data: Provide data on all finishing products and special coating. Clearly identify paint type and intended use as outlined by schedules at the end of this section. Include material safety data sheets.
- B. Color samples:
  - 1. Submit two draw-down samples, 8 by 8 inch in size for each product, finish and color for review by Owner & Engineer.
- C. Manufacturer's instructions: Indicate special surface preparation procedures, substrate conditions requiring special attention.
- D. Maintenance data: Provide in Materials and Finishes Manual under provisions of Division 1.
- E. Painting Schedule—to accomplish final color selection by Engineer and Owner, prepare painting schedule identifying:
  - 1. All surfaces to be painted.
  - 2. Surface preparation used.
  - 3. Type of primer coating, film thickness, shop or field applied.
  - 4. Type of finish coating, film thickness, shop or field applied.
  - 5. Provide area for color selection of each surface by Engineer and Owner.

## 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years.
- B. Applicator: Company specializing in performing the work of this section with minimum 5 years' experience and approved by manufacturer for surface preparation and application of similar coating systems.

## 1.7 REGULATORY REQUIREMENTS

- A. Conform to AWWA D102 for potable water coating systems.
- B. Conform to applicable fire code for flame and smoke rating requirements for finishes.
- C. Comply with all health and fire regulations of agencies having jurisdiction for storage of materials.
- D. Comply with current state requirements for air quality control permit and OSHA standards for sandblasting.
- E. Comply with current State of Colorado requirements for Volatile Organic Compounds (VOC's) for all coatings.

1.8 PRE-APPLICATION CONFERENCE

- A. Conform to provisions under Division 1.
- B. Coating manufacturer or manufacturer's representative will conduct a meeting to establish specific surface preparation procedures acceptable to Engineer and application and protection procedures of finished surfaces.
- C. Contractor will coordinate meeting 7 days prior to the start of work in this section. Inspection and testing procedures will be established under provisions of Division 1.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability. Maintain labels legible and intact.
- C. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, Federal specification number and instructions for mixing and reducing and VOC content.
- D. Store only acceptable project materials on project site.
- E. Store coating materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions and acceptable to Engineer.
- F. Restrict storage area to paint materials and related equipment.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Comply with manufacturer's instructions as to environmental conditions under which coatings and coating systems can be applied.
- B. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating manufacturer's instructions and acceptable to Engineer.
- C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating manufacturer's instructions and acceptable to Engineer.
- D. Do not apply finish in areas where dust is being generated.
- E. Minimum application temperatures for latex paints: 45 degrees F for interiors; 50 degrees F for exterior; unless permitted otherwise by manufacturer's instructions and acceptable to Engineer and Owner.
- F. Relative humidity: 85 percent maximum.
- G. Provide lighting level of 80 foot candles measured mid-height at substrate surface.

## 1.11 EXTRA MATERIALS

- A. Furnish under provisions of Division 1.
- B. Provide 1 gallon of each color, type, and surface texture used for the work to Owner.
- C. Label each container with color, type, texture, room locations, in addition to the manufacturer's label.
- D. Provide two-part coating systems to be un-mixed. Open containers are not acceptable.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. The following manufacturers products may be incorporated into the project:
  - 1. Benjamin Moore.
  - 2. PPG Industries, Inc. (Pittsburgh Paints).
  - 3. Sherwin-Williams (Basis-of-Design).
  - 4. Tnemec.
- B. Rust inhibitive general purpose primer:
  - 1. Sherwin Williams – Pro-Industrial Pro-Cryl Universal Primer B66-130 Series.
- C. Concrete block interior wall filler:
  - 1. Sherwin Williams – Pro-Industrial Heavy Duty Block Filler 75-100 Series.
- D. Gloss alkyd enamel:
  - 1. Sherwin Williams – Pro-Industrial Waterbased Alkyd Urethane Enamel B53-1050 Series.
- E. Semi-gloss alkyd enamel:
  - 1. Sherwin Williams – Pro-Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series.
- F. Field catalyzed epoxy primer and finish coatings:
  - 1. Sherwin Williams – Macropoxy 646
- G. High Performance Acrylic:
  - 1. Sherwin Williams – Sher-Cryl HPA B66 Series

### 2.2 MATERIALS

- A. Use product of single manufacturer for coating systems for each type of surface.

- B. Use paint compatible with shop coating or primer for field coating of shop painted or primed surfaces.
- C. Use only mercury-free, fume-proof paint for intermediate and finish coats. Paint must be suitable for atmosphere containing hydrogen sulfide.
- D. Use only lead-free paint or paint that does not cause discoloration in treatment plant atmosphere.
- E. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.
- F. Accessory materials: Linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes specified, or commercial quality.
- G. Patching materials: Latex filler.
- H. Fastener head cover materials: Latex filler.

### 2.3 FINISHES

- A. Refer to schedule at end of section for surface finish and color schedule.
- B. Use paint by same manufacturer for successive field coats.
- C. Field coats to be compatible with shop applied undercoats.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify site conditions under provisions of Division 1.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished that will adversely affect execution, permanence, or quality of work and which will not allow preparatory work outlined in preparation of surfaces. Report any condition that may potentially affect proper application prior to commencement of work.
- D. Do not proceed with surface preparation or coating application until conditions are suitable.
- E. Test shop applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
  1. Plaster and gypsum wallboard: 10 percent.
  2. Masonry, concrete, and concrete unit masonry: 8 percent.

3. Interior wood: 12 percent, measured in accordance with ASTM D2016.
4. Exterior wood: 12 percent, measured in accordance with ASTM D2016.
5. Concrete floors: 8 percent.

### 3.2 SANDBLASTING PROCEDURES

A. Steel: Structural, tanks, pipe, angles, beams, equipment, wall plates, pipe hangers, rods, pipe supports, stairs, platforms, handrails, plus steel accessories:

1. Non-submerged: SSPC-SP6.
2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10.
3. High temp surfaces to 1,200F: SSPC-SP10.

B. Ductile iron, cast iron: Pipe, equipment, fittings, plus miscellaneous items:

1. Non-submerged: SSPC-SP6.
2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10.

C. Mill coated steel pipe, structural, tank:

1. Exterior non-submerged: SSPC-SP6.
2. Exterior submerged or partially submerged: SSPC-SP10.

D. Concrete: Floor, wall, channels and troughs:

1. Submerged or partially submerged: SSPC-SP7.

E. Profile of sandblasted surface: 2 mils

F. Do not allow surfaces to become wet after blasting and before painting.

G. Apply primer same day as blasting.

H. Air free of water and oil.

I. Confine sandblast sand to area being prepared.

J. Protect nameplates, valve stems, rotating equipment, motors and other damageable items.

K. Do not reuse sand.

L. Plug pipe, holes, or openings before sandblasting keep covered until sand is removed.

### 3.3 PREPARATION OF SURFACES

A. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.



- B. Correct defects and clean surfaces which affect work of this section. Remove existing coatings that exhibit loose surface defects.
- C. Seal with shellac and seal marks which may bleed through surface finishes.
- D. Impervious surfaces:
  - 1. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach.
  - 2. Rinse with clean water and allow surface to dry.
- E. Aluminum surfaces scheduled for paint finish:
  - 1. Remove surface contamination by steam or high pressure water.
  - 2. Remove oxidation with acid etch and solvent washing.
  - 3. Apply etching primer immediately following cleaning.
- F. Asphalt, creosote, or bituminous surfaces scheduled for paint finish:
  - 1. Remove foreign particles to permit adhesion of finishing materials.
  - 2. Apply compatible sealer or primer.
- G. Insulated coverings: Remove dirt, grease, and oil from canvas and cotton.
- H. Galvanized surfaces:
  - 1. SSPC-SP1.
  - 2. Spot prime defects after repair.
- I. Concrete and unit masonry surfaces scheduled to receive paint finish:
  - 1. Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter.
  - 2. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry.
  - 3. Remove stains caused by weathering or corroding metals with a solution of sodium metasilicate after thoroughly wetting with water.
  - 4. Allow to dry.
- J. Exterior uncoated steel and iron surfaces:
  - 1. Remove grease, mill scale, weld splatter, dirt, and rust.
  - 2. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting where directed by Engineer; clean by washing with solvent.
  - 3. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned.
  - 4. Spot prime paint after repairs.
- K. Shop primed steel surfaces:

1. Sand and scrape to remove loose primer and rust by power tool wire brushing or sandblasting where directed by Engineer.
2. Feather edges to make touch-up patches inconspicuous.
3. Clean surfaces with solvent.
4. Prime bare steel surfaces.

L. Interior wood items scheduled to receive paint finish:

1. Wipe off dust and grit prior to priming.
2. Seal knots, pitch streaks, and sappy sections with sealer.
3. Fill nail holes and cracks after primer has dried; sand between coats.

M. Wood and metal doors scheduled for painting: Seal top and bottom edges with primer and under all hardware of wood doors.

### 3.4 MIXING AND TINTING

- A. Deliver paints and enamels ready-mixed to job site.
- B. Mix only in mixing pails, suitably sized, non-ferrous or oxide metal pans.
- C. Use tinting colors recommended by manufacturer for specific type of finish.
- D. Do not add any adulterants or unauthorized thinners.
- E. Thoroughly mix each time paint withdrawn from container.
- F. Keep containers closed tightly except while paint is withdrawn.
- G. All paint factory mixed.
- H. Thinning only permitted to obtain recommended coverage at lower application temperatures.

### 3.5 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply initial coating until moisture content of surface is within moisture limitations recommended by manufacturer's instructions and acceptable to Engineer.
- C. Do not apply finishes to surfaces that are not dry. Comply with recommendation of manufacturer for drying time between succeeding coat.
- D. Apply each coat to uniform finish free of visible brush marks, streaks, laps and missed areas.
- E. Vary slightly the color of successive coats. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- F. Apply coating with suitable brushes, rollers, or spraying equipment:

1. Do not exceed rate of application recommended by manufacturer for the type of surface involved.
  2. Keep brushes, rollers, and spraying equipment clean, dry, free from contaminants and suitable for the finish required.
- G. Sand wood and metal lightly between coats to remove defects to achieve smooth uniform finish acceptable to Engineer.
- H. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
- I. Allow applied coat to dry before next coat is applied.
- J. Provide tie coats where recommended by manufacturer's instructions and acceptable to Engineer.
- K. Do not apply additional coats until completed coat has been inspected by the Engineer:
1. Only inspected coats of paint will be considered in determining number of coats applied.
- L. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping
- M. Rate of application:
1. Coverage not greater than value recommended by manufacturer's instructions.
  2. Use of paint thinner not to be used as means of extending coverage of paint.
- N. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surfaces.
- O. Prime concealed surfaces of interior woodwork with primer paint.
- P. Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
- Q. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners or depressions.
- R. Apply primer on all work before glazing.
- S. Adjust stained and natural finishes as necessary to obtain identical appearance on all woodwork of a similar type.
- T. Refinish whole wall where portion of finish has been damaged or is not acceptable.
- U. Surfaces to be painted with water-thinned paint: Spot prime exposed nails and other ferrous metals with aluminum paint.
- V. Remove all dents from doors and frames and apply one coat of finish paint before installing hardware.

- W. Finish coat Owner supplied equipment within recommended period of time with compatible coating.

### 3.6 CLEANING

- A. Clean work under provisions of Division 1.
- B. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
- C. Remove spilled or splattered paint from all finished surfaces.
- D. Do not mar or scratch surface finish of items being cleaned.

### 3.7 PROTECTION OF FINISHED WORK

- A. Use drop cloths, masking tape and other measures to protect all surfaces from accidental spraying, spattering, or spilling of paint.
- B. Prepare surface and re-coat surfaces damaged during delivery and installation or by construction activity.
- C. Repair all damage caused by coating other items of work:
  - 1. Immediately remove paint deposited on surfaces not to be coated.
- D. Protect galvanized steel finishes and repair damaged surfaces as follows:
  - 1. Power tool clean foreign matter, rust, slag residue, weld splatter from both damaged and contiguous undamaged area.
  - 2. Clean with phosphoric acid base.
  - 3. Brush apply two coats of cold galvanizing compound and overlap at least two inches onto contiguous undamaged area.

### 3.8 SURFACES NOT TO BE PAINTED

- A. Except as otherwise required or directed, do not paint the following surfaces:
  - 1. Exposed surfaces of aluminum, except ductwork and conduit.
  - 2. Polished or finished stainless steels. Unfinished or dull stainless steel shall be painted.
  - 3. Nickel or chromium.
  - 4. Galvanized surfaces, except piping, conduit, duct work, and other items specifically noted.
  - 5. Rubber and plastics that flex.
  - 6. Copper instrument or pressure gauge tubing.
  - 7. Piping concealed in inaccessible plumbing chases and above suspended ceilings.
  - 8. Acoustical plaster and panel ceilings.
  - 9. Exterior colored CMU and exterior concrete.
  - 10. Surfaces specified to be factory finished.

### 3.9 PIPING AND ACCESSORIES

- A. Coat all exposed piping and piping in accessible places in accordance with color schedule in Division 1.
- B. Coat any piping not scheduled to be color-coded to match adjacent wall or ceiling surface, include appropriate service identification and flow direction arrows.
- C. Locate lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee and at intervals of approximately 25 feet in straight runs of pipe acceptable to Engineer.
- D. Provide metal tags instead of lettering for all pipes with outside diameter or pipe covering diameter 5/8 inch or smaller. Tags are to be of stainless steel or aluminum with identifying lettering stamped in and fastened to pipe with suitable chains.

### 3.10 FIELD QUALITY CONTROL

- A. Comply with inspection and film thickness testing requirements of this section, SSPC-Volume 1, Chapter 6 and SSPC-PA 2. Provide under provisions of Division 1.
- B. General inspection sequence as follows:
  - 1. Pre-surface preparation observation.
  - 2. Measurement of ambient conditions.
  - 3. Evaluation of compressor (air cleanliness) and surface preparation equipment.
  - 4. Determination of surface preparation cleanliness and profile.
  - 5. Review of application equipment.
  - 6. Witnessing of coating mixing.
  - 7. Observing coating application.
  - 8. Determination of wet film thickness (non-metallic substrates).
  - 9. Determination of dry film thickness (metallic or non-ferrous metal substrates).
  - 10. Pinhole and holiday testing of shop coatings as required.
  - 11. Adhesion testing as required.
  - 12. Evaluating cure.
- C. Wet film thickness (WFT) testing:
  - 1. Standard “notch” configuration or circular dial gauges.
  - 2. Use for concrete, wood or other non-metallic substrates.
  - 3. Determine dry film thickness per the following:
$$WFT = \frac{\text{specified dry film thickness}}{\% \text{ solids by volume}}$$
Decrease percent solids by volume if coating is thinned per the following:
$$WFT = \frac{\text{specified dry film thickness}}{\% \text{ solids by volume} / (100\% + \% \text{ thinner added})}$$
  - 4. Calibrate gauge per manufacturers instructions acceptable to Architect.

D. Dry film thickness (DFT) testing:

1. Type 1: Magnetic pull-off type gauge.
2. Type 2: Fixed probe magnetic flux gauge with microprocessor.
3. Calibrate gauge per manufacturers instructions and SSPC-PA 2 acceptable to Engineer.
4. Use eddy current type gauge or probe attachment for non-ferrous metal substrates.
5. Gauge accuracy:  $\pm 10$  percent.

E. Number of measurements and minimum thickness in accordance with SSPC-PA 2:

1. Make five (5) separate spot measurements (average of three readings for each spot measurement) spaced evenly over each 100 square feet (9.3 square meters) of area to be measured.
2. The average of five spot measurements for each such 100 square foot area shall not be less than the specified thickness.
3. No single spot measurement in any 100 square foot area shall be less than 80 percent of the specified thickness.
4. Any one of three readings which are averaged to produce each spot measurement may under-run by a greater amount.
5. The five spot measurements shall be made for each 100 square feet of area as follows:
  - a. For structures not exceeding 300 square feet in area, each 100 square foot area shall be measured.
  - b. For structures not exceeding 1,000 square feet in area, three 100 square foot areas shall be randomly selected and measured.
  - c. For structures exceeding 1,000 square feet in area, the first 1,000 square feet shall be measured as stated above and for each additional 1,000 square feet of area or increment thereof, one 100 square foot area shall be randomly selected and measured.
6. If the dry film thickness for any 100 square foot area is not in compliance with the requirements above, then each 100 square foot area shall be measured.
7. Contractor shall reimburse Owner for additional time required to inspect each 100 square foot area in addition to the above spot measurement requirements. An additional coat may be applied in lieu of additional testing.

F. Other size areas or number of spot measurements may be adjusted as appropriate for the size and shape of the structure to be measured as determined by Architect.

3.11 SCHEDULE—METAL SURFACES

A. All non-submerged surfaces of structural and miscellaneous steel exposed in exterior locations including galvanized surfaces, doors and frames, steel handrails, pumps, motors, and other machines and process equipment:

1. Primer: One coat catalyzed epoxy primer—4 mils.
2. Finish: One coat polyurethane—4 mils.
3. Total dry film thickness: 8 mils.

- B. All non-submerged surfaces of structural and miscellaneous steel exposed inside buildings, including roof joists, roof deck, other galvanized surfaces, doors and frames, steel handrails, pumps, motors, other machines and process equipment:
    - 1. Primer: One coat catalyzed epoxy primer—4 mils.
    - 2. Finish: One coat polyurethane—4 mils.
    - 3. Total dry film thickness: 8 mils.
  
  - C. All buried or partially buried exterior structural steel angles, plates, supports, fittings, connections, flanges, fasteners and bolts:
    - 1. Primer: One coat rust inhibitive zinc-rich shop primer—3 mils.
    - 2. Finish: One coat coal tar epoxy—18 mils.
    - 3. Total dry film thickness: 20 mils minimum.
- 3.12 SCHEDULE—MASONRY SURFACES
- A. Concrete block surfaces exposed in interior locations:
    - 1. Pretreatment: One component block filler.
    - 2. Primer: One coat epoxy polyamide—6 mils.
    - 3. Finish: One coat epoxy polyamide—6 mils.
    - 4. Total dry film thickness: 12 mils.
- 3.13 SCHEDULE—COLORS
- A. Colors to be selected by Owner and Engineer from Contractor provided paint sample chart at time of paint submittal.

END OF SECTION

## SECTION 10 44 16 - FIRE EXTINGUISHERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10.
    - b. Faulty operation of valves or release levers.
  - 2. Warranty Period: Six years from date of Substantial Completion.



## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

### 2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - b. Larsens Manufacturing Company.
  - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type Class ABC Steel Container: UL-rated 4-A; 60-B; C, 10 lb. nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION

## SECTION 11 05 00 - COMMON WORK RESULTS FOR EQUIPMENT

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Provide all tools, supplies, materials, equipment, and all labor necessary for the furnishing, construction, installation, testing and operation of equipment and appurtenant work, complete and operable, all in accordance with the requirements of the Contract Documents.
- B. The provisions of this Section shall apply to all equipment specified and where referred to, except where otherwise specified or shown.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. All equipment, products and their installation shall be in accordance with the following standards, as applicable and as specified in each section of these specifications:
  - 1. ASTM International (ASTM)
  - 2. American Public Health Association (APHA)
  - 3. American National Standards Institute (ANSI)
  - 4. American Society of Mechanical Engineers (ASME)
  - 5. American Water Works Association (AWWA)
  - 6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - 7. American Welding Society (AWS)
  - 8. National Fire Protection Association (NFPA)
  - 9. Federal Specifications (FS)
  - 10. National Electrical Manufacturers Association (NEMA)
  - 11. Manufacturer's published recommendations and specifications
  - 12. Oregon Occupational Safety and Health Division (OR-OSHA)
- B. The following standards have been referred to in this Section of the specifications:
  - 1. ASTM International:
    - a. ASTM A48 - Specification for Gray Iron Castings.
    - b. ASTM A108 - Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
  - 2. American National Standards Institute (ANSI):
    - a. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.

- b. ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and Other Special Alloys.
  - c. ANSI B46.1 - Surface Texture.
  - d. ANSI S12.6 - Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors.
3. American Society Mechanical Engineers (ASME):
- a. ANSI/ASME B1.20.1 - General Purpose Pipe Threads (Inch).
  - b. ANSI/ASME B31.1 - Power Piping.
4. American Water Works Association (AWWA):
- a. AWWA C206 - Field Welding of Steel Water Pipe.

### 1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, Submittal Procedures.
- B. Shop Drawings:
- 1. Furnish complete shop drawings for all equipment specified in the various sections, together with all piping, valves, and controls for review by the Engineer.
  - 2. Include calculations showing equipment anchorage forces and the capacities of the anchorage elements where required.
- C. Special Tools:
- 1. Supply one complete set of special tools where necessary for the assembly, adjustment, and dismantling of the equipment.
  - 2. Tools shall be suitable for professional work and manufactured by a recognized supplier of professional tools such as Snap On, Crescent, Stanley, or equal.
- D. Spare Parts:
- 1. Obtain and submit from the Manufacturer a list of suggested spare parts for each piece of equipment.
  - 2. Furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.
  - 3. Spare parts shall be supplied when indicated in the appropriate equipment specification sections.
- E. Torsional and Lateral Vibration Analysis:

1. Where required by the individual equipment sections, provide a torsional and lateral vibration analysis of the equipment, in accordance with Section 01 33 00, Submittal Procedures.
2. Equipment shall be designed and constructed such that the natural frequency of the drive train is avoided by a minimum of 25 percent throughout the entire operating range.
3. Analysis shall be performed by a specialist experienced in this type of work and approved by the Engineer.
  - a. The specialist, or their assigned representative who shall similarly be experienced in this type of work and who shall be approved by the Engineer, shall visit the Site during startup and testing of the equipment to analyze and measure the amount of equipment vibration, certify that the operating frequency avoids the natural frequency by 25 percent, and make a written recommendation for keeping the vibration at a safe limit.

#### 1.4 QUALITY ASSURANCE

- A. Demonstrate all equipment meets the specified performance requirements. Provide the services of an experienced, competent, and authorized service representative of the Manufacturer of each item of major equipment, who shall visit the Site to perform the following tasks:
  1. Assist the Contractor in the installation of the equipment.
  2. Inspect, check, adjust if necessary, and approve the equipment installation.
  3. Start-up and field-test the equipment for proper operation, efficiency, and capacity.
  4. Perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.
  5. Instruct the Owner's personnel in the operation and maintenance of the equipment. Instruction shall include step-by-step trouble shooting procedures with all necessary test equipment.
- B. The costs of all inspection, startup, testing, adjustment, and instruction work performed by said factory-trained representatives shall be borne by the Contractor. When available, the Owner's operating personnel will provide assistance in the field testing.
- C. Tolerances and clearances shall be as shown on the shop drawings and shall be closely adhered to. Machine work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts.
- D. The type of finish shall be the most suitable for the application and shall be in accordance with ANSI B46.1.
- E. Unless otherwise noted, all equipment furnished shall have a record from the same manufacturer of at least 3 years successful, trouble-free operation in similar applications.

## 1.5 DELIVERY, HANDLING, AND STORAGE

- A. All equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage.
- B. Each item of equipment shipped shall have a legible identifying mark corresponding to the equipment number shown or specified for the particular item.
- C. All equipment shall be protected from exposure to corrosion and shall be kept thoroughly dry at all times.

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Hearing Protection:
  - 1. At each high noise level location, where equipment produces noise exceeding 85 dBA at 3 feet or exceeding OSHA noise level requirements for operator safety, supply two pairs of high attenuation hearing protectors.
  - 2. Ear protectors shall meet the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz.
  - 3. Hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband.
  - 4. Protectors shall be stored in a weatherproof, labeled, steel cabinet, furnished by the Contractor and mounted in an approved location near the noise producing equipment.
- B. Welding:
  - 1. Unless otherwise specified or shown, all welding shall be by the metal arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS.
  - 2. Qualification of welders shall be in accordance with the AWS Standards governing same.
- C. Protective Coatings:
  - 1. All equipment shall be painted or coated in accordance with the specifications under Division 09 – Finishes.
  - 2. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil.
  - 3. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.
- D. All equipment subject to vibration shall be provided with restrained spring type vibration isolators or pads per Manufacturer's written recommendations.

- E. Shop fabrication shall be performed in accordance with the Specifications and the Engineer-approved shop drawings.

## 2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. Design Loads: All equipment supports, anchors, and restraint shall be adequately designed for static, dynamic, wind, and seismic loads.
- B. Equipment foundations shall be as per Manufacturer's written recommendations.
- C. All equipment shall be mounted as shown on the Manufacturer's standard details, unless otherwise shown or specified.

## 2.3 PIPE HANGERS, SUPPORTS, AND GUIDES

- A. All pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment.

## 2.4 FLANGES AND PIPE THREADS

- A. All flanges on equipment and appurtenances provided under this Section shall conform to ANSI B16.1, Class 125 or B16.5, Class 150, unless otherwise shown.
- B. All pipe threads shall be in accordance with ANSI/ASME B1.20.1 and with requirements of Section 40 05 13, Common Work Results for Process Piping.

## 2.5 COUPLINGS

- A. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Where required for vertical shafts, three-piece spacer couplings or universal type couplings for extended shafts shall be installed.
- B. The Contractor shall have the Equipment Manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. Taper-lock bushings may be used to provide for easy installation and removal on shafts of various diameters.
- D. Where universal type couplings are shown, they shall be equipped with grease fittings.

## 2.6 BEARINGS

- A. Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association (AFBMA).
- B. All field-lubricated type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
- C. All lubricated-for-life bearings shall be factory-lubricated with the Manufacturer's recommended grease to insure maximum bearing life and best performance.

- D. Except where otherwise specified or shown, all bearings shall have a minimum B-10 life expectancy of 5 years or 20,000 hours, whichever occurs first.
- E. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as specified or shown, or as recommended in the published standards of the Manufacturer. Split type housings may be used to facilitate installation, inspection, and disassembly.
- F. Sleeve type bearings shall have a Babbitt or bronze liner.

## 2.7 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment.

## 2.8 GASKETS AND PACKINGS

- A. Gaskets shall be in accordance with the requirements of Section 40 05 13, Common Work Results for Process Piping.
- B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron type "V" packing shall be Garlock No. 432, John Crane "Everseal" or equal.
- C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the Manufacturer and approved by the Engineer.

## 2.9 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location.
- B. Nameplates shall contain the Manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

# PART 3 EXECUTION

## 3.1 WELDING

- A. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions.
- B. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed.
- C. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions.
- D. All sharp corners of material to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

### 3.2 COUPLINGS

- A. The Contractor shall have the Equipment Manufacturer select or recommend the size and type of coupling required to suit each specific application.
- B. Installation shall be per Equipment Manufacturer's printed recommendations.

### 3.3 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate all necessary space and structural requirements, clearances, utility connections, signals, and outputs with the Contractor's subcontractors.
- B. If the packaged system has any additional features other than specified, the Contractor shall coordinate such features and furnish all material and labor necessary for a complete installation, as required by the Manufacturer, at no additional cost to the Owner.

END OF SECTION



## SECTION 26 00 00

### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. This section includes basic electrical requirements for materials and methods applicable to electrical equipment specified under this section and other related sections.
  - 1. Conduit
  - 2. Boxes
  - 3. Duct Bank
  - 4. Wire and Cable
  - 5. Wiring Devices and Device Plates
  - 6. Maintenance Materials
  - 7. Grounding Materials
  - 8. Luminaries
  - 9. Power Panels
  
- B. Related Sections:
  - 1. Division 01 – Shop Drawings and Product Data
  - 2. Division 01 – Construction Facilities and Temporary Controls
  - 3. Division 01 – Materials and Equipment
  - 4. Division 01 – Operation & Maintenance Data
  - 5. Division 31 – Earthwork
  - 6. Division 03 – Cast-In-Place Concrete
  - 7. Division 09 – Coatings

##### 1.2 REFERENCES

- A. UL – All applicable standards
- B. IEEE – All applicable standards
- C. IPCEA – All applicable standards
- D. NEMA – All applicable standards
- E. ANSI/NFPA 70 – National Electrical Code
- F. ANSI C2 – National Electrical Safety Code
- G. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies
- H. ANSI/NEMA OS 1 – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

- I. ANSI/NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

### 1.3 SUBMITTALS

- A. Information covering all material that is to be used on this project shall be submitted.
- B. Each sheet of descriptive literature shall be clearly marked to identify the material or equipment for which it pertains.
- C. Equipment on submitted sheets that is not for this project shall be crossed out.
- D. As a minimum the following information shall be submitted:
  - 1. Lamp fixture descriptive sheets identified by the fixture schedule letter
  - 2. Equipment sheets shall identify what the equipment refers to by calling out the name of the equipment on the sheet.
  - 3. Schematics and connection diagrams for all electrical equipment shall be submitted.
  - 4. Submit all types of conduit and cables with manufacturer and sizes as well as all appurtenances.

### 1.4 QUALITY ASSURANCE

- A. Supplier's qualifications
  - 1. The entire system shall be designed, coordinated, and supplied by a qualified Electrical Contractor who is regularly engaged in the business of building electrical systems for water and wastewater projects. The Electrical Contractor shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.
- B. Coordination
  - 1. The electrical equipment shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
  - 2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
  - 3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.
  - 4. All service entrance work shall be in accordance with the local utility standards.
  - 5. The electrical contractor shall coordinate all service entrance work with the local utility. The local utility is Excel Energy.
  - 6. The electrical contractor shall NOT pay for the utility's work. That shall be billed directly to the owner.

7. Accurately record actual locations of conduit, duct banks, panels, and accessories.

## 1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable Building Code.
- B. Electrical: Conform to latest version of NFPA 70.
- C. Coordinate, obtain and pay for all permits, inspections and approvals of authority having jurisdiction.
- D. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1.

## 1.6 WARRANTY

- A. The electrical contractor shall warrant the supplied equipment and labor for a period of one year from the date of system acceptance.

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The work for this project is for a functioning city building. All new work shall be done in a way that allows the existing facility to maintain its operation.
- B. All equipment furnished under this Section shall be selected by the Contractor for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
  - 1. Conduit
    - a. Minimum Size:  $\frac{3}{4}$  inch unless otherwise specified, or  $\frac{1}{2}$  inch for luminaries pendants.
    - b. Underground Installations:
      - i) Over 100V: More than five feet from foundation wall: Use thick wall nonmetallic conduit.
      - ii) Within five feet from foundation wall: Use rigid steel conduit
      - iii) Under 100V: Use rigid steel conduit
      - iv) Minimum size: 1 inch.
    - c. Outdoor Locations, Above Grade: Use rigid steel conduit.
    - d. In Slab Above Grade:
      - i) Use rigid steel conduit for circuits that are 24V or less.
      - ii) Use rigid thick wall non-metallic conduit for 120V to 480V circuits.
      - iii) Maximum Size Conduit in Slab: 2 inch, 1 inch for conduits that cross over each other, or with structural engineer's approval.

- iv) Conduits shall not be spaced closer than 3 conduit widths on center.
- v) Aluminum conduit shall not be embedded in concrete.
- vi) Conduits shall not pass through a structural concrete beam without the structural engineer's approval.
- e. In or under slab on grade:
  - i) Use rigid steel conduit for circuits that are 24V or less.
  - ii) Use rigid thick wall non-metallic conduit.
- f. Wet and damp locations: Use rigid steel conduit or aluminum conduit.
- g. Dry locations:
  - i) Concealed: In walls or above ceilings, use rigid steel or aluminum conduit.
  - ii) Exposed: Use rigid steel conduit or aluminum conduit.
- h. Rigid Steel Conduit.
  - i) Rigid steel conduit shall be heavy wall, hot-dipped galvanized, and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.
- i. Rigid Nonmetallic Conduit (PVC).
  - i) PVC conduit shall be heavy wall, schedule 40, shall be UL labeled for aboveground and underground uses.
- j. PVC-Coated Rigid Steel Conduit.
  - i) The conduit shall be rigid steel and before the PVC coating is applied, the hot-dipped galvanized surfaces shall be coated with a primer to ensure a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit at a thickness of at least 40 mils. A two part urethane chemically cured coating shall be applied at a nominal 2 mil thickness to the interior of all conduit and fittings.
  - ii) Manufacturers: Ocal, PermaCote, or Robroy Industries.
- k. Rigid Aluminum Conduit.
  - i) Rigid aluminum conduit shall be heavy wall and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.
- l. Flexible connections
  - i) Conduit: Moisture proof vinyl jacketed, liquid-tight, hot-dipped galvanized flexible steel and shall be UL labeled.
  - ii) Connectors: Watertight, Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or equal.
- 2. Outlet Boxes
  - a. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, Galvanized.
    - i) Luminaries and equipment supporting boxes: rated for weight of equipment supported.
    - ii) Concealed installations.
  - b. Nonmetallic outlet boxes: ANSI/NEMA OS 2.
  - c. Cast Boxes: NEMA FB 1, Type FD, Cast Ferroalloy.
    - i) Provide gasketed cover by box manufacturer.
    - ii) Provide threaded hubs.
    - iii) Models VXF, GRFX as manufactured by Crouse-Hinds.
    - iv) Models SEH, JBDX, with mounting lugs as manufactured by Appleton.

3. Pull and Junction
  - a. Sheet Metal Boxes: NEMA OS 1, Galvanized Steel.
  - b. Surface-Mounted Cast Metal Box: NEMA 250, Type 4 flat-flanged, surface-mounted junction box.
    - i) Material: Galvanized cast iron Cast aluminum in corrosive areas.
    - ii) Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
    - iii) Model: WCB as manufactured by Crouse-Hinds.
  - c. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
    - i) Material: Galvanized cast iron.
    - ii) Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
    - iii) Cover Legend: ELECTRIC.
    - iv) Model: WPD as manufactured by Crouse-Hinds.
4. Large Junction Boxes and Wiring Gutters
  - a. Indoor Locations:
    - i) Steel, NEMA 12.
  - b. Outdoors:
    - i) Stainless steel.
    - ii) Weather-tight NEMA 4.
  - c. Construction.
    - i) Provide rigid handles for box covers larger than 9 sq. ft. or heavier than 25 lbs.
    - ii) Provide split covers for covers larger than 12 sq. ft.
    - iii) Aluminum boxes in concrete not allowed.
5. Seal Fittings
  - a. Model ESU with Apelco sealing cement and fiber, as manufactured by Appleton.
  - b. Model EZS with Chico X Fiber and Chico A compound as manufactured by Crouse-Hinds.
6. Deflection Fittings
  - a. Locations:
    - i) Underground conduit runs.
    - ii) Runs between concrete sections subject to relative movement.
  - b. Material:
    - i) Ferroalloy hubs.
    - ii) Neoprene outer jacket.
    - iii) Stainless steel jacket clamps.
    - iv) Molded plastic inner sleeve.
    - v) Tinned copper braid grounding strap.
  - c. Model XD as Manufactured by Crouse-Hinds.
7. Expansion Fittings
  - a. Locations:
    - i) In long conduit runs, to permit linear movement caused by thermal expansion and contraction.
    - ii) In long conduit runs to prevent conduit from buckling.
    - iii) Indoors and outdoors, where conduit expansion occurs or where there is a wide temperature range.

- iv) At structural expansion joints.
- b. Material:
  - i) End fittings: Ferroalloy.
  - ii) Body: Steel conduit.
- c. Provide Bonding Strap When Used Outdoors.
- d. Model XJ, as Manufactured by Appleton and Crouse-Hinds.
- 8. Flexible Sealing Compound
  - a. "Duxseal" as Manufactured by Johns-Manville.
  - b. "Permagum" as Manufactured by In mount.
- 9. Coal Tar Epoxy Paint
- 10. Wire and Cable
  - a. 600 Volt Power Cable
    - i) General Use:
      - a) Conductors: Single, copper, 12 AWG minimum.
      - b) All conductors shall be stranded.
      - c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
      - d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
      - e) Or as specified for service entrances.
    - ii) Service entrance and 4 AWG and above:
      - a) Conductors: Single, stranded, copper.
      - b) Insulation: 600V cross-linked polyethylene, UL Type XHHW/USE or THHN.
      - c) Suitability: Wet or dry locations at 75°C and 90° C copper temperature.
    - iii) Terminations
      - a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap standard cable around screw type terminals
  - b. Lighting Circuits
    - i) General Use:
      - a) Conductors: Single, copper, 12 AWG minimum.
      - b) Conductors may be solid or stranded.
      - c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
      - d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
    - ii) Terminations:
      - a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap stranded cable around screw type terminals.
  - c. Control circuits
    - i) General Use:
      - a) Conductors: Single, tinned copper, 14 AWG
      - b) All conductors shall be stranded
      - c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
    - ii) Millivolt or Milliampere Instrumentation and Control.
      - a) Conductors: 18 AWG stranded copper, 2 or 3 as required.
      - b) Insulation: 15 mils, minimum, 90°C PVC.
      - c) Shield: Mylar aluminum tape with 20 AWG copper drain wire, fully covering conductors.
      - d) Jacket: 20 mils, minimum, 80°C PVC.
      - e) Suitability: Wet or dry steel conduit.

- iii) Manufacturers: Belden “UL Instrumentation Cable – 1032A”, Samuel Moore “Dekoron ICMX” No. 1852-686 and 1862-686, or equal.
- d. Telephone and Networking
  - i) Cable.
    - a) The cables shall be rated for use in communications circuits.
    - b) The cables shall be rated for riser applications.
    - c) The cables shall be rated for 75 degrees Celsius applications.
    - d) The cables shall be free of defects and splices.
    - e) The cables shall be rated for outdoor applications.
    - f) The cables shall be rated for P-MSHA applications.
    - g) The cables shall pass a -40 degree Celsius cold bend test per UL 1581.
    - h) The cables must be UL third party verified to ANSI/TIA/EIA-586-B.2 Category 5e.
    - i) The cable shall be ROHS compliant.
    - j) The cable shall be CE compliant.
    - k) Conductors
      - 1) The conductors shall be solid, bare copper per ASTM B-3.
      - 2) The conductors shall be #24 AWG (.20 sq mm).
    - l) Insulation
      - 1) The insulation shall be polyolefin.
      - 2) The insulation shall be free of defects and splices.
    - m) Pairs
      - 1) The cable shall contain four pairs.
      - 2) The insulated conductors shall be bonded together down the entire length of the pair.
      - 3) The pairs shall be marked with a permanent, extruded stripe identification of tip and ring insulated conductors.
      - 4) Each pair shall have a unique twist length to minimize pair to pair coupling.
    - n) Shielding
      - 1) Shielding shall be an aluminized foil with the foil facing inward, where required.
      - 2) Unshielded cables shall be acceptable except where shielding is required for the system.
    - o) Jacket.
      - 1) All cables shall have a continuous jacket of Polyvinyl Chloride (PVC).
      - 2) Jacket thickness: The jackets shall be .030" (.75 mm) nominal thickness.
      - 3) The jackets shall be ultraviolet (UV) radiation and sunlight resistant per UL 1581.
      - 4) The jackets shall be oil resistant per UL 1581 Class 43.
    - p) Manufacturer: Belden “Industrial Data Solutions – 7923A” or equal.

## 11. Wiring Devices

- a. General:
  - i) Industrial Specification grade.

- ii) White.
  - b. Receptacles:
    - i) 120 V duplex outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 5362, or approved equal.
    - ii) 120 V duplex GFCI outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 7899, or approved equal.
    - iii) 240 V duplex outlets: NEMA 6-20R, 3 wire, grounding, 20A, 250 V, Leviton 5462, or approved equal.
    - iv) Welding outlets: 50A, 125/250V, 3 pole, 4 wire, grounding, NEMA 14-50R, Leviton 55050, or approved equal.
  - c. Light Switches:
    - i) 277 V lighting circuits: 20 amp, 120/277 V, Leviton 1221-2W to 1224-2W, or approved equal.
12. Device Plates
- a. General:
    - i) Mounting hardware countersunk and finished to match plate.
    - ii) Provide over-sized plates where standard plates do not cover wall opening.
    - iii) Provide engraving as indicated on drawings.
  - b. Indoors:
    - i) Surface mounted devices: Galvanized or cadmium-plated steel.
    - ii) Flush mounted devices in other finished areas: Phenolic plastic, white.
    - iii) All other flush mounted devices: Type 302 stainless steel.
  - c. Outdoors and Indoors when identified on Drawings as Weatherproof:
    - i) Weatherproof with spring doors for receptacles and with provisions for padlocking switches on and off.
    - ii) Provide an adaptor plate for flush mounted device plates, Crouse-Hinds FS031, or equal.
13. Grounding and Bonding
- a. Provide rod electrodes, exothermic connections and mechanical connections.
  - b. Building perimeter ground cable shall be minimum of 4/0 AWG bare copper.
  - c. Duct bank ground cable shall be minimum of 4/0 AWG bare copper.
  - d. Other ground cable shall be as noted on the drawings.
14. Luminaries
- a. Furnish products as specified on drawings.
  - b. Install ballasts, lamps, and specified accessories at factory.
  - c. Accessories:
    - i) Provide swivel-type box covers.
    - ii) Provide threaded conduit pendants.
  - d. Provide all lamps and required mounting hardware.
15. Power Panels
- a. General:
    - i) Circuit breaker panel board.
    - ii) With neutral.
    - iii) Dead front.
  - b. Enclosure:
    - i) NEMA 12, surface in unfinished areas, NEMA 1 flush in finished areas or as indicated on the drawings.



- ii) Door with latch and lock.
  - iii) Typewritten circuit directory.
  - iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.
  - c. Circuit Breakers:
    - i) Molded case thermal magnetic.
    - ii) Multiple pole breakers shall be common trip.
    - iii) Bolt-in.
    - iv) Individually front replaceable.
    - v) Indicating “On”, “Off”, and “Tripped”.
    - vi) RMS symmetrical interrupting capacity shall be as indicated on the drawings.
    - vii) Breakers, trip ratings, and number of poles as indicated on the drawings.
  - d. Buses:
    - i) Three phase and neutral bus insulated from cabinet.
    - ii) Ground bus.
      - a) Connected to cabinet.
      - b) Clamp type lug for supply circuit and each load circuit.
      - c) Removable bond to neutral bus.
    - iii) Copper bussing.
    - iv) Ampere and voltage ratings as indicated on the drawings.
    - v) Bracing coordinated with circuit breakers interrupting capacity.
16. Lighting Panels
- a. General:
    - i) Circuit breaker panel board.
    - ii) With neutral.
    - iii) Dead front.
  - b. Enclosure:
    - i) NEMA 1 or as indicated on the drawings.
    - ii) Door with latch and lock.
    - iii) Typewritten circuit directory.
    - iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.
  - c. Circuit Breakers:
    - i) Molded case thermal magnetic.
    - ii) Multiple pole breakers shall be common trip.
    - iii) Bolt-in or plug-in.
    - iv) Individually front replaceable.
    - v) Indicating “On”, “Off”, and “Tripped”.
    - vi) 10,000 amp RMS symmetrical interrupting capacity at 208 V or as indicated on the drawings.
    - vii) Handle clips to prevent casual operation for circuit breakers indicated on drawings.
    - viii) Ground fault interrupting breakers with a sensitivity of 5mA for receptacle branch circuit and where indicated on drawings.
    - ix) Breakers, trip ratings, and number of poles as indicated on the drawings.
  - d. Buses:
    - i) Two phase and neutral bus insulated from cabinet.

- ii) Ground bus.
    - a) Connected to cabinet.
    - b) Clamp type lug for supply circuit and each load circuit.
    - c) Removable bond to neutral bus.
  - iii) Copper.
    - iv) Ampere and voltage ratings as indicated on the drawings.
    - v) Bracing coordinated with circuit breakers interrupting capacity.
17. Dry-Type Specialty Transformers.
- a. Phase, voltage current ratings as indicated on drawings.
  - b. Two 2½% full capacity taps below normal voltage.
  - c. Dry type, wall floor or MCC mounted as indicated on the drawings, enclosed for wiring in conduit.
  - d. Self air-cooled.
  - e. Suitable for indoor NEMA 4.
  - f. Insulation system and average winding temperature rise for rated KVA as follows:
    - i) 1-15 KVA: Class 185 with 115°C rise.
    - ii) 16-500 KVA: Class 220 with 115°C rise.
  - g. Sound Levels: NEMA ST20.
  - h. Ground core and coil assembly to enclose by means of a visible flexible copper grounding strap.
  - i. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise
18. Control Stations.
- a. Enclosures:
    - i) Indoors: NEMA 4X.
    - ii) Outdoors: NEMA 4X
  - b. Pilot Devices:
    - i) Refer to specification section 40 90 00.
  - c. Nameplates:
    - i) Pilot devices: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
    - ii) Control station: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
19. Equipment Disconnects
- a. General:
    - i) Heavy-duty safety switches.
    - ii) Square D or Cutler-Hammer.
  - b. Enclosure:
    - i) Indoor dry areas: NEMA 12.
    - ii) Outdoor: NEMA 4X.
    - iii) Corrosive Areas: NEMA 4X.
    - iv) Use above guidelines unless otherwise noted on drawings.
    - v) Padlocked external operating handle.
  - c. Switch:
    - i) 25,000 amp symmetrical withstand or as indicated on the drawings.

- ii) Poles to match equipment served.
  - iii) 600 VAC.
  - iv) Continuous current rating not less than the serving branch circuit over current protection.
  - v) Non-fusible except where fusing is required by the served equipment or as noted on the drawings.
20. Separately Enclosed Motor Starters.
- a. General:
    - i) Starters shall have a disconnecting means.
    - ii) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
    - iii) Dry type control power transformer for 120VAC control power sized to handle all loads simultaneously, both primary leads fused and one secondary lead fused and one secondary lead grounded.
    - iv) Two spare NO and NC auxiliary contacts.
    - v) Pilot devices.
    - vi) Nameplates to identify the starter and all the items in the starter.
    - vii) Square D or Cutler-Hammer.
  - b. Enclosure:
    - i) Indoor dry areas: NEMA 12.
    - ii) Outdoors & corrosive areas: NEMA 4X.
    - iii) External operating handle to be interlocked with the door to prevent opening door when handle is in the closed position.
    - iv) Padlocked external operating handle.
  - c. Contactor:
    - i) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
    - ii) 1 phase: NEMA size 0 minimum size or as indicated on the drawings.
    - iii) Rated for the voltage being provided.
    - iv) 120 VAC coils.
    - v) Non-reversing NEMA rated magnetic starters.
  - d. Overloads:
    - i) One solid state overload relay in each phase.
    - ii) External manually reset push button for reset of the overload relay.
    - iii) Overloads shall provide phase loss tripping capability.
  - e. Disconnecting Device:
    - i) 3 phase: MCP type disconnect rated at 25KAIC minimum.
    - ii) 1 phase: MCP or fused type disconnect rated at 10KAIC minimum.
21. Surge Protective Device (SPD).
- a. General:
    - i) SPD units shall be installed as shown on the drawings.
    - ii) SPD units shall be appropriate for the voltages indicated on the drawings.
    - iii) Approved manufacturers: Cutler Hammer, Square D, LEA, or equal.
    - iv) SPD units shall comply with UL 1449 and 1283.
    - v) SPD units shall comply with IEEE C62.41 and IEEE C62.45.
    - vi) SPD units shall have a 30 amp disconnect directly before the TVSS unit.
    - vii) SPD units shall have indication for trouble alarms and surge count.
    - viii) For assembled equipment the SPD unit shall be of the same manufacturer as the assembled equipment.

b. Ratings:

i) Maximum let through voltage shall be:

Mode	120/208	277/480
L-N or L-G	400V	800V
L-L	800V	1800V

ii) Minimum total surge current capability:

Location	Per Phase	Per Mode
Switchgear	250 KA	125KA
MCC	160KA	80KA
Panelboards	120KA	60KA

## 2.2 SPARE PARTS

- A. The Supplier shall furnish and deliver the following spare parts.
- B. The following spare parts to be furnished as a minimum:
  - 1. 25% replacement lamps for lighting fixtures.
  - 2. 25% replacement lamps for pilot light.
  - 3. Two (2) sets of each type of fuse used in the project.
  - 4. Two (2) spare ballast of each type specified.
- C. All of the above parts shall be provided as spare parts and shall be packaged new in the original manufacturer's packaging. A list of spare parts shall be provided.

## PART 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

- A. General Requirements
  - 1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.
- B. Inspection
  - 1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
    - a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.
- C. Equipment Installation
  - 1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.

- a. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors ¼” from wall be corrosion resistant spacer.
- b. Seal the base of all outdoor switchgear, motor control center, and similar equipment with grout.
- c. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers.
- d. Electrical work shall conform to the construction schedule and progress of other trades.
- e. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
- f. Perform all work in accordance with manufacturer's instructions.
  - i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
  - ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
- g. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.

D. Identification:

1. Conduit. All conduits shall be provided with identification tags. Tags shall be brass nameplates with 3/8” high lettering and attached to the conduits by means of stainless steel wire. Conduits shall be identified at both ends with the same identification number.
2. Cable. Except for lighting and receptacle circuits, each individual wire in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination. Power wires without individualized identification numbers shall be color coded with electrical tape or colored wire jacket. The wire markers shall be of the heat-shrinkable tube type.
3. Control Stations. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends (“start”, “stop”, etc.) as indicated on the drawings. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.
4. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

E. Raceways:

1. General:
  - a. Except as otherwise indicated on drawings, conduit shall be concealed in finished areas and exposed in unfinished areas.
  - b. Rigid steel conduit and aluminum conduit connections and terminations shall be reamed, de-burred, threaded and provided with bushings.
  - c. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out. Conduit hubs outdoors and in wet locations.

- d. Provide deflection fittings across structural joints where structural movement is allowed.
  - e. Keep conduit clear of structural openings and indicated future openings.
  - f. Provide flashing and seal watertight conduits through roofs and metal walls.
  - g. Neatly grout conduit into any opening cut into structure.
  - h. Cap or plug conduits during construction to prevent the entrance of trash, dirt and water.
  - i. Minimum conduit size shall be 3/4", except 1/2" for luminaries pendants or as noted on drawings.
  - j. Seal conduits with flexible sealing compound forced to a minimum depth equal to the conduit diameter after cable is installed.
    - i) At handholes, manholes, and vaults.
    - ii) Building entrance junction boxes.
    - iii) One inch or larger connections to equipment.
  - k. Provide flexible conduit where flexible connections are necessary, including each motor without flexible cord.
    - i) Keep length to a minimum, not to exceed 6' maximum.
    - ii) No sharp bends.
  - l. Provide suitable pull string in each empty or spare conduit.
2. Conduit exposed in structures:
- a. Install parallel to structural members and surface.
  - b. Install conduits of the same general routing parallel with symmetrical bends.
  - c. Arrange supports to prevent misalignment during wiring installation.
  - d. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
  - e. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.
  - f. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
  - g. Provide suitable pull string in each empty conduit except sleeves and nipples.
  - h. Maintain 6" clearance to ducts, piping and flues.
  - i. Support rigidly with galvanized or cadmium-plated hardware and framing materials, including nuts and bolts.
  - j. Provide expansion fittings at 100' centers outdoors, 200' centers indoors; in each conduit run longer than 100' outdoors, 200' indoors.
  - k. Provide galvanized pipe caps on conduit stubs for future use.
  - l. Allow 7' headroom for horizontal conduit runs, except along structures, piping equipment or where not possible.
  - m. Except as otherwise indicated, do not install exposed conduit in water chambers.
  - n. Where allowed, coat conduit exposed in water chambers with 2 coats of coal tar paint with paint injuries repaired or use PVC coated conduit.
3. Conduit concealed in structure:
- a. Install between reinforcing steel in slabs with reinforcing in both faces.
  - b. Install under reinforcing steel in slabs where only a single layer is provided.
  - c. Terminate conduit for future use in equipment or by galvanized couplings and conduit plugs flush with structural surfaces. Seal plugs with self-leveling caulk.

- d. Maximum of two conduits crossing each other in slab.
- 4. Underground:
  - a. One inch minimum.
  - b. Encased in concrete.
    - i) Two inches between conduits.
    - ii) Three inches over conduit where not reinforced.
    - iii) Three inches over reinforcing.
    - iv) Reinforced at and 5' past portion on disturbed earth or subject to traffic.
    - v) Reinforced within 5' of a structure, manhole or vault.
    - vi) Reinforced for entire length and 2' beyond each adapter to steel conduit if non-metallic is used in duct bank.
    - vii) Where capped underground, reinforce the last 2' and extend steel and conduit 2' past end of duct bank. Paint all un-encased metal with 2 coats of coal tar paint.
    - viii) Continue encasement on outdoor risers to 3" above grade and crown and chamfer top.
  - c. Two foot minimum bend radius at vertical risers, 3 foot elsewhere.
  - d. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building.
  - e. Provide 3 foot minimum earth cover.
  - f. Install underground conduits through buildings, manhole, handhole and vault walls in box outs as indicated on the drawings.
  - g. All steel inside manholes, handholes and vaults shall be galvanized with bared spots treated with zinc rich paint.
  - h. Provide ¾" galvanized steel pulling eyes on opposite walls below the centerline of each duct bank.
  - i. Provide end bells at wall terminations and adapters for steel conduit continuations for non-metallic duct systems.
  - j. Isolate intercommunication and milliampere level instrumentation circuits from all power wiring raceways, conduits, boxes, vaults, manhole and handhole.
  - k. Provide a full-size extension for each underground conduit entering a building.
  - l. Rigid nonmetallic conduit (PVC) shall be fastened no less than every 4 feet.
- 5. Junction boxes and wiring gutters:
  - a. Install electrical boxes as shown on drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
  - b. Install pull boxes and junction boxes to maintain headroom and to present neat mechanical appearance.
  - c. Install level and plumb.
  - d. Where indicated, provide a removable side opposite underground duct banks.
  - e. At least code size including space for full size continuation of any conduit not originally continued.
  - f. Arrange conduit for maximum space for future conduits.
  - g. Support boxes independently of conduit except cast box that is connected to rigid metal conduits both supported within 12 inches of box.

## F. Wire and Cable

### 1. General:

- a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner.
- b. Terminate stranded cable with lugs, cup washers, or pressure type connectors; do not wrap stranded cable around screw type terminals.
- c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable.
- d. Splice cables only at readily accessible locations.
- e. Do not pull cable tight against bushings or press heavily against enclosures.
- f. Use cable pulling lubricants as recommended by the cable manufacturer.
- g. Use swab to clean conduits and ducts before pulling cables.
- h. Install cable and accessories in accordance with manufacturer's instructions.
- i. Where necessary to prevent heavy loading of cable connectors due to cable weight, support cables in vertical risers with woven cable grips.
- j. Coil and tape spare cable ends.
- k. Support each 250 MCM or larger cable, and each conduit group of smaller cables from manholes, handholes or vault walls.
  - l. Use Stranded conductor for feeders and branch circuits.
  - m. Use stranded conductors for control circuits.
  - n. Use conductor not smaller than 12 AWG for power and lighting circuits.
  - o. Use conductor not smaller than 16 AWG for control circuits.
  - p. Use 10 AWG conductors for 20 ampere, 120 Volt branch circuits longer than 100 feet.
  - q. Pull all conductors into raceway at same time.
  - r. Use suitable wire pulling lubricant for building wire 8 AWG and larger.
  - s. Protect exposed cable from damage.
  - t. Neatly train and lace wiring inside boxes, equipment, and panel boards.
  - u. Clean conductor surfaces before installing lugs and connectors.
  - v. Make splices, taps, and terminations to carry full ampacity of conductors.

### 2. Special cables:

- a. Isolate networking and milliampere level instrumentation cables from all power circuits.
- b. Isolate telephone cables from all other circuits.

### 3. Conductor identification:

- a. Color code all service, feeder, and branch circuit conductors, 277/480 VAC and above as follow:
  - i) Phase A: Brown
  - ii) Phase B: Orange
  - iii) Phase C: Yellow
  - iv) Neutral: White
  - v) Ground: Bare or Green
- b. Color code all feeder, and branch circuit conductors, 120/208 VAC as follows:
  - i) Phase A: Red.
  - ii) Phase B: Black.
  - iii) Phase C: Blue.
  - iv) Neutral: White.



- v) Ground: Bare or Green.
- c. Identify single control conductors by color coding orange and by labeling each end of conductors by color coding orange and by labeling each end of conductor with heat shrink-tube type wire markers.
- d. Identify multi-conductor instrumentation and control cables with heat shrink-tube type wire markers.
- e. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer.

G. Wiring Devices:

1. Flush mount wiring devices in concealed conduit system.
2. Surface mount wiring devices in exposed conduit systems.
3. Provide extension rings to bring outlet boxes flush with finished surface.
4. Clean debris from outlet boxes.
5. Install products in accordance with manufacturer's instructions.
6. Install devices plumb and level.
7. Install switches with OFF position down.
8. Install receptacles with grounding pole on bottom.
9. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
10. Connect wiring devices by wrapping conductor around screw terminal.
11. Use jumbo size plates for outlets installed in masonry walls.
12. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
13. Install wall switch 48 inches above finished floor.
14. Install convenience receptacle 24 inches above finished floor.
15. Inspect each wiring device for defects.
16. Operate each wall switch with circuit energized and verify proper operation.
17. Verify that each receptacle device is energized.
18. Test each receptacle device for proper polarity.
19. Test each GFCI receptacle device for proper operation.
20. Adjust devices and wall plates to be flush and level.

H. Grounding Materials:

1. Coordinate installation with other disciplines.
2. Verify that final backfill and compaction has been completed before driving rod electrodes.
3. Install Products in accordance with manufacturer's instructions.
4. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
5. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
6. Provide bonding to meet Regulatory Requirements.
7. Install ground cable through building walls within 3' below finish grade and prepare a water stop.
8. Install ground rods and cables as deep in earth as possible and as far from structure as possible, not closer than 6".

9. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection.
10. Connect ground conductors to equipment by ground lugs or clamps.
  - a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings.
  - b. If an explosion-proof or submersible enclosure is not provided with grounding means, provide an adjacent junction box with a ground lug.
  - c. Bond grounding system to station piping by connection to the first flange inside the building on either a suction or discharge pipe which will form a good ground connection:
    - i) Drill and tap the flange.
    - ii) Provide a bolted connection.
    - iii) Bond with a copper bar or strap.
  - d. Form ground conductors on equipment to the contours of the equipment.
  - e. Install main ground cables with encased underground conduit banks in earth at least 3” below 1 corner of the duct bank.
  - f. Bond ground cables in underground circuits to main ground cables at each manhole, handhole, and vault.

#### I. Luminaries

1. Install in the general locations and arrangement indicated on drawings.
2. Align luminaries in rows vertically and horizontally except as otherwise required.
3. Install clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.
4. Adjust luminaries location as required by field conditions.
5. Examine each luminaries to determine suitability for lamps specified.
6. Install in accordance with manufacturer’s instructions.
7. Install suspended luminaries using pendants supported from swivel hangers. Provide pendant length required to suspend luminaries at indicated height.
8. Support luminaries larger than 2x4 foot size independent of ceiling framing.
9. Locate recessed ceiling luminaries as indicated on reflected ceiling plan.
10. Install surface mounted luminaries and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
11. Install recessed luminaries to permit removal from below.
12. Install accessories furnished with each luminaire.
13. Bond products and metal accessories to branch circuit equipment grounding conductor.
14. Install specified lamps in each luminaire emergency lighting unit and exit sign.
15. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
16. Aim and adjust luminaries as directed.
17. Relamp luminaries that have failed lamps at Substantial Completion.
18. Clean electrical parts to remove conductive and deleterious materials.
19. Remove dirt and debris from enclosure.
20. Clean photometric control surfaces as recommended by manufacturer.
21. Clean finishes and touch-up damage.

J. Lighting Panel

1. Wall mount in unfinished areas, flush mount in finished areas.
2. Install lighting panel in accordance with NEMA PB 1.1.
3. Install lighting panel plumb. Provide supports. Height: 6 ft. to top of lighting panel; install lighting panel taller than 6 ft. (2M) with bottom no more than 4 in. above floor.
4. Provide filler plates for unused spaces in lighting panels.
5. Provide typed circuit directory for each branch circuit in lighting panel. Revise directory to reflect circuiting changes required to balance phase loads.
6. Measure steady state load currents at each lighting panel feeder; rearrange circuits in the lighting panel to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
7. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

K. Networking – EtherNet/IP cabling

1. Install sufficient networking cable, as shown in the contract drawings, to provide a complete networked system.
2. Terminate all wiring with RJ-45 connectors rated for Cat 5e cable transmissions.
3. Test every communication cable, and provide a testing certificate with the results.

3.2 FIELD QUALITY CONTROL

A. Low Voltage Cable Testing

1. Test 600 V power cables for continuity and freedom from short circuits and ground, except where grounding is intentional immediately after installation.
2. Test all circuits with a 500 V megger or its equivalent.
3. Replace conductors which read less than 1.5 Megohms between conductors and ground.

3.3 PROTECTION AND STORAGE

A. Protection of equipment during storage:

1. During construction, all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously. Any means necessary shall be used to protect the equipment at the Contractor's expense.

END OF SECTION

## SECTION 26 29 23

### VARIABLE FREQUENCY DRIVES AND CONTROL EQUIPMENT

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. This section covers the furnishing of variable frequency drives (VFDs) with all associated labor, material, tools, equipment, appurtenances, and service in accordance with the contract documents.

##### 1.02 SUBMITTALS

- A. Submittals shall be required as noted in Section 40 00 00.

##### 1.03 QUALITY ASSURANCE

- A. VFD Supplier's qualifications
  - 1. Acceptable Manufacturers.
    - a. Square D "Model 71".
    - b. Allen Bradley "Model 700" Series.
    - c. Cutler-Hammer, "Model SVX9000" or "Model DG1 "Series.
    - d. Invertek
    - e. Without exception.
    - f. Where a listed manufacturer's standard product does not meet the requirements of this specification, the standard unit shall be modified to meet all the requirements of this specification.
- B. Coordination
  - 1. Verify all motor sizes and specifications from approved mechanical, process, and instrumentation shop drawings, contract drawings, and contract documents. It is the Contractor's responsibility to fully coordinate the VFDs with the provided driven equipment. All equipment provided under this section shall comply with the requirements of the general project requirements (Materials and Equipment – Division 01), Section 26 00 00, and Section 40 90 00 of these specifications.
- C. The VFD Supplier shall be the same as the Instrumentation Supplier for the equipment in section 40 90 00.
- D. Warranty
  - 1. The VFD supplier shall warrant the hardware for a period of one year from the date of system acceptance.

## PART 2 PRODUCTS

### 2.01 GENERAL REQUIREMENTS

- A. All equipment furnished under this section shall be selected by the VFD supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
  - 1. Interchangeability. All VFDs shall be products of the same manufacturer and of the same series or product line.

### 2.02 MATERIALS AND EQUIPMENT

- A. The following specifications shall apply to the VFDs.
  - 1. The variable frequency drives shall consist of a 480 V adjustable frequency inverter with integral control, sequence logic, and self diagnostics as specified herein. The drives shall be of “pulse width modulated inverter” (PWM) type employing semi-conductor technology. The VFD shall limit harmonic distortion reflected onto the system to a voltage and current distortion level as defined by the latest version of IEEE 519 for general system application. Harmonic filter shall reside in VFD enclosure unless specified in drawings.
  - 2. VFD enclosures:
    - a. The enclosure ratings shall be as noted on the drawings
    - b. All devices noted on the drawings shall be installed in the VFD enclosure.
  - 3. Each VFD of 50 HP or more shall be provided with a line side filter for mitigation of harmonic noise.
    - a. The filter shall be a passive harmonic filter capable of limiting the harmonic distortion from this drive to meet the requirements of IEE-519 1992.
    - b. The filter shall be as manufactured by TCI HG7 Series, Mirrus Filter AUHF, or approved equal.
    - c. The filter shall mount in the VFD enclosure.
    - d. Fans shall be as required for both the VFD and the filter.
  - 4. Each VFD under the size of 50 HP shall be provided with a 5% line side filter.
  - 5. The VFD shall be rated:
    - a. As shown on the drawings
    - b. Constant torque
    - c. 480 V, 3 phase, 60Hz
    - d. Microprocessor based static adjustable frequency controller designed to provide continuous speed adjustment of 3 phase motors
    - e. Provide energy-efficient, low loss speed control in the range from 4 to 70 Hz.
    - f. Provide the Town receipts and required information for all VFDs to enable energy rebate through Excel Energy.
  - 6. The VFDs shall operate in an ambient temperature range of 10C to 30C at an altitude of 5,351 feet above sea level.

7. The following microprocessor-based, door-mounted operator controls and status indication shall be provided:
  - a. Run/stop selection with LED indication.
  - b. Speed control selection with LED indication.
  - c. Current limit indication.
  - d. Microprocessor fault.
  - e. Reset button.
  - f. Manual speed adjustment.
  - g. Frequency indication.
  - h. Amp-meter.
  - i. Output voltage meter.
  - j. Elapsed time meter.
  - k. Error and Fault log.
8. The following basic control functions and features shall be provided:
  - a. Interface for external hand-off-auto switch and control signals as shown on the drawings.
  - b. Interface for external 4-20mA speed reference signal.
  - c. 4-20mA output signal for VFD speed indication.
  - d. Output relays with dry contacts wired to terminals for functions shown on the drawings.
  - e. Control power transformer and power supplies as required.
9. The following standard protective functions shall be provided on the VFDs:
  - a. Input AC circuit breaker with an interlocked, padlockable handle mechanism.
  - b. Electronic instantaneous over-current protection.
  - c. DC bus under-voltage protection.
  - d. DC bus over-voltage protection.
  - e. DC bus over-voltage protection.
  - f. Overload warning.
  - g. Controlled over-temperature protection.
  - h. Over-frequency protection.
  - i. Phase loss protection.
  - j. Output terminal short circuit protection.
10. The following standard independent adjustments shall be provided on the VFDs:
  - a. Minimum frequency.
  - b. Maximum frequency.
  - c. Four preset speeds initiated by contact closures.
  - d. Adjustable acceleration times.
  - e. Voltage boost.
  - f. Volts-to-hertz ratio.
  - g. Current limit.
  - h. Critical frequency avoidance zones.
  - i. Jog input.
  - j. Selectable auto restart.

## PART 3 EXECUTION

### 3.01 INSTALLATION REQUIREMENTS

A. General Requirements

1. It shall be the Supplier's responsibility to ensure that the entire electrical equipment is installed in a satisfactory condition per these specifications and the manufacturer's requirements.

B. Inspection.

1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
  - a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation.

1. VFDs shall be installed in individual VFD cabinets that shall contain all the devices shown on the drawings as being part of the VFD system.

D. Adjustment and Cleaning

1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

3.02 CUSTOMER TRAINING

- A. The Supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of this equipment. The training sessions shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of a 2-hour session; the schedule shall be arranged and coordinated with the Engineer.

END OF SECTION

## SECTION 31 05 13 - SOILS FOR EARTHWORK

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.
- B. Section includes:
  - 1. Subsoil materials
  - 2. Topsoil materials
- C. Related Sections
  - 1. Section 31 10 00 - Site Clearing
  - 2. Section 31 22 13 - Rough Grading
  - 3. Section 31 23 16 - Excavation

#### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
- B. ASTM International (ASTM):
  - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))
  - 2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
  - 3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

#### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Materials Source: Submit name of imported materials source.



C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.4 QUALITY ASSURANCE

A. Furnish materials of each type from same source throughout the Work.

B. Soil Testing:

1. Soil sampling and testing to be completed by an independent laboratory approved by the Engineer.
2. Frequency of testing shall be determined by the Engineer.
3. All soil testing shall be paid for by the Contractor.

C. Compaction Tests:

1. Maximum density at optimum moisture content determined by ASTM D698 (AASHTO T99).
2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.

D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

## PART 2 PRODUCTS

### 2.1 SUBSOIL MATERIALS

A. Subsoil Type S1, Select Native Material:

1. Select earth obtained from on-site excavations approved for use by Engineer.
2. Graded.
3. Free of peat, humus, vegetative matter, organic matter, and rocks larger than 6 inches in diameter.
4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.

B. Subsoil Type S2, Imported Fill Material:

1. Imported earth approved for use by Engineer.

2. Imported granular material consisting, essentially, of sand, gravel, rock, slag, disintegrated granite or a combination of such materials. Coarse portions shall be sound fragments of crushed or uncrushed material.
3. Supplied material shall be a well-graded mixture containing sufficient soil mortar, crusher dust, or other proper quality binding material which, when placed and compacted in the roadway structure, shall result in a firm, stable foundation.
4. Material shall be graded within the following limits:

Sieve Size (Inch)	Percent Passing by Weight
2 ½ inch	100
2 inch	95-100
No. 4	30-60
No. 200	5-15

5. Liquid Limit: <35
6. Plasticity Index: <6

## 2.2 TOPSOIL MATERIALS

### A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.
2. Engineer decision shall be final as to determination of what material is topsoil quality.
3. Graded.
4. Free of roots, rocks larger than 1/2-inch subsoil, debris, large weeds, and foreign matter.
  - a. Screening: Single screened.

### B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.
2. Friable loam.
3. Reasonably free of roots, rocks larger than 1/2-inch, subsoil, debris, large weeds, and foreign matter.

- a. Screening: Single screened.
- 4. Acidity range (pH) of 5-1/2 to 7-1/2.
- 5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

### 2.3 SPOILS

- A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Engineer.
- B. Make arrangements for disposal of the material at no additional cost to the Owner.
- C. Landfill permit to be obtained by the Contractor and provided to Engineer prior to commencement of disposal.

### 2.4 SOURCE QUALITY CONTROL

- A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698 (AASHTO T99).
- B. When tests indicate materials do not meet specified requirements, change material, or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.
- C. Furnish materials of each type from same source throughout the Work.
- D. Testing frequency in accordance with 01 45 00, Quality Control.

## PART 3 EXECUTION

### 3.1 EXCAVATION

- A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.
- B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.
- C. When practical, do not excavate wet topsoil.
- D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.
- E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.

- F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

### 3.2 STOCKPILING

- A. Stockpile soils at locations shown in the Drawings or at locations as approved by Engineer for redistribution as specified.
  - 1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the Project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.
  - 2. No additional payments will be made for stockpiling excavated materials off-site.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
  - 1. Grade surface of stockpiles to prevent ponding of water.
  - 2. Cover stockpiles to minimize the infiltration of water.
- F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

### 3.3 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
- B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

## SECTION 31 10 00 - SITE CLEARING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.
- B. Related Sections:
  - 1. Section 02 41 00 - Demolition
  - 2. Section 31 22 13 - Rough Grading

#### 1.2 DEFINITIONS

- A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.
- C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- D. Limits of Disturbance: Work area boundary as shown on the Plans.
- E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.
- F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

#### 1.3 SUBMITTALS

- A. The following list of submittals are to be made under this section and in accordance with the provisions of Sections 01 33 00 – Submittal Procedures, and 01 45 00 – Quality Control. At the time the first submittal is made under this section, include the addresses and phone numbers of nearest manufacturer's representative
  - 1. Provide a copy of any pertinent Drawings, this specification section and all related Sections and with all addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements
- B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.

- C. Certification or disposal permit for landfill and/or waste disposal site.
- D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

#### 1.4 QUALITY ASSURANCE

- A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.
- B. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.
- C. Conform to applicable local, state, and federal codes for environmental requirements and disposal of debris,
  - 1. Burning on project site will not be permitted.
  - 2. Use of herbicides will not be permitted.
- D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.
- E. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.
- B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

### PART 3 EXECUTION

#### 3.1 GENERAL

- A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing, and Stripping Plan.

- B. Remain within the property and/ or easement lines at all times as shown in the Drawings.
- C. Do not injure or deface vegetation or structures that are not designated for removal.

### 3.2 EXAMINATION

- A. Verify existing plant life designated to remain is tagged or identified.
- B. Identify waste and salvage areas for placing removed materials.

### 3.3 PREPARATION

- A. Carefully coordinate the work of this Section with all other work and construction.
- B. Call Local Utility Line Information service at 811, not less than three working days before performing Work.
- C. Request underground utilities to be located and marked within and surrounding construction areas.
  - 1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.
  - 2. Keep all active utilities intact and in continuous operations.
- D. Prepare Site only after:
  - 1. Erosion and sediment controls are in place.
    - a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with Mile High Flood Control District Urban Storm Drainage Criteria Manuals and ESC Permits.
  - 2. Tree and vegetation protection is installed.
    - a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.
    - b. Follow the provisions set forth in 01 56 39, Temporary Tree and Plant Protection for all temporary tree and plant protection measures.
  - 3. Temporary fencing is installed along the Limits of Disturbance.
  - 4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

### 3.4 PROTECTION

- A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.
- B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.
- C. Preservation and Trimming of Trees, Shrubs, and Other Vegetation:
  - 1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.
  - 2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.
  - 3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.
  - 4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
  - 5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.
  - 6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Engineer. Cost shall be borne by the Contractor.
- D. Landscaped Areas:
  - 1. When any portion of the Work crosses private property, native grass, or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.
  - 2. Conduct Work in a manner that will restore original conditions as nearly as practicable.
  - 3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.



4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.
  5. Wherever sod cannot be saved and restored, the ground must be reseeded or resodded and cared for until a stand of grass is reestablished.
  6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.
  7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.
- E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, signs, sidewalks, paving, and curbs.
- F. Repair and Replacement:
1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.
  2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

### 3.5 LIMITS

- A. As follows, but not to extend beyond Limits of Disturbance and within the approved disturbance limits in the Environmental Zones:
1. Excavation: 5 feet beyond top of cut slopes.
  2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.
  3. Fill:
    - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill slopes.
    - b. Stripping: 2 feet beyond toe of permanent fill slopes.
  4. Structures: 15 feet outside of new structures foundation.
  5. Roadways: Clearing, grubbing, scalping, and stripping 5 feet from roadway shoulders in unimproved areas.
  6. Other Areas: As shown.

- B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall not be permitted without written approval of Owner.

### 3.6 CLEARING AND GRUBBING

- A. Clear and grub areas within limits shown in approved Clearing, Grubbing, and Stripping Plan.
- B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.
- C. Clearing:
  - 1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except those trees and shrubs noted to remain in the Drawings or as directed by the Engineer.
  - 2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.
  - 3. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:
  - 1. Future Structures and Building Areas                      24 Inches
  - 2. Roads and Parking Areas    18 Inches
  - 3. All other Areas    12 Inches

### 3.7 TREE REMOVAL

- A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.
- B. Tree Salvage: As shown on the Plans.
- C. No trees may be removed unless approved and permitted by the Engineer.
- D. Do not top trees unless otherwise specified or approved by Owner in writing.

- E. Refer to Section 01 56 39, Temporary Tree and Plant Protection for tree protection requirements.

### 3.8 REMOVAL AND DISPOSAL

- A. Native vegetation may be mulched and used on Site.
- B. Asphalt and Gravel Surfaces:
  - 1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.
  - 2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Engineer.
  - 3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.
- C. Remove debris, rock, abandoned piping, and extracted plant life from Site.
- D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.
  - 1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the Work.
  - 2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.
- E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- F. Do not burn or bury materials on site. Leave site in clean condition.
- G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.
- H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.
- I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

### 3.9 CLEANUP

- A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.
- B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.
- C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Engineer.
- D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Engineer.

END OF SECTION

## SECTION 31 22 13 - ROUGH GRADING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.
- B. Section Includes:
  - 1. Excavating topsoil
  - 2. Excavating subsoil
  - 3. Cutting, grading, filling, and rough contouring of Site
- C. Related Sections:
  - 1. Section 01 45 00 - Quality Control
  - 2. Section 31 05 13 - Soils for Earthwork
  - 3. Section 31 10 00 - Site Clearing
  - 4. Section 31 23 16 - Excavation

#### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
- B. ASTM International (ASTM):
  - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
  - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))
  - 3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
  - 4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.
- C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

### 1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

### 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Subsoil Fill: Type **S1 and S2** as specified in Section 31 05 13, Soils for Earthwork.
  1. Type S1, Select Native Material, as may be available.
  2. Type S2, Imported Fill Material, as may be required.
- B. Topsoil: As specified in Section 31 05 13, Soils for Earthwork.
  1. Type TS1, Select Native Topsoil Material, as may be available.
  2. TS2, Imported Topsoil Material, as may be required.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

### 3.2 PREPARATION

- A. Call Local Utility Line Information service at 811 not less than 3 working days before performing Work.
  - 1. Request underground utilities to be located and marked within and surrounding construction areas.
  - 2. Notify Engineer of any potential conflicts resulting from utility locations and the Drawings.
  - 3. Notify utility company to remove and relocate utilities, as may be necessary.
- B. Identify required lines, levels, contours, and datum.
- C. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with the Work of this Section.

### 3.3 TOPSOIL EXCAVATION

- A. Excavate and stockpile topsoil as specified in Section 31 05 13, Soils for Earthwork.

### 3.4 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.
- B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.
- C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.
- D. When excavating through roots, perform Work by hand and cut roots with sharp axe.
- E. Benching Slopes: Horizontally bench existing slopes greater than 1:2 to key placed fill material to slope to provide firm bearing.
- F. Stability: Replace damaged or displaced subsoil as specified for fill.

### 3.5 FILLING

- A. General:

1. Grading and filling operations shall not take place when weather conditions and moisture content of fill materials prevent the attainment of specified density.
  2. Vertical curves or roundings at abrupt changes in slope shall be established as approved by Engineer.
  3. Bring all graded areas to a relatively smooth, even grade and slope by blading or dragging. Remove high spots and fill depressions.
- B. Fill areas to contours and elevations shown in the Drawings with unfrozen materials.
- C. Topsoil Fill:
1. Scarify prepared subgrade to depth of 12 inches immediately prior to placing topsoil.
  2. Place topsoil in areas to be seeded to depths indicated in the Drawings, minimum depth of 12 inches.
  3. Place topsoil material loose; do not compact, do not place in wet or muddy conditions.
- D. Place material in continuous layers as follows:
1. Subsoil Fill: Maximum 8 inches compacted depth.
  2. Structural Fill: Maximum 12 inches compacted depth.
  3. Granular Fill: Maximum 12 inches compacted depth.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Make grade changes gradual. Blend slope into level areas.
- G. Repair or replace items indicated in the Drawings to remain which are damaged by excavation or filling. All costs shall be borne by the Contractor.

### 3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

### 3.7 FIELD QUALITY CONTROL

- A. Perform laboratory material tests in accordance with AASHTO T99.
- B. Perform in place compaction tests in accordance with the following:



1. Density Tests: ASTM D2922
  2. Moisture Tests: ASTM D3017
- C. Frequency and location of testing is dependent upon type of material placed. See Section 01 45 00, Quality Control for testing requirements.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

END OF SECTION

## SECTION 31 23 16 – EXCAVATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.
- B. Section Includes:
  - 1. Excavating for paving, roads, and parking areas
  - 2. Excavating for slabs-on-grade
  - 3. Excavating for site structures
  - 4. Excavating for landscaping
- C. Related Sections:
  - 1. Section 01 45 00 - Quality Control
  - 2. Section 02 41 00 - Demolition
  - 3. Section 31 05 13 - Soils for Earthwork
  - 4. Section 31 10 00 - Site Clearing
  - 5. Section 31 22 13 - Rough Grading

#### 1.2 DEFINITIONS

- A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. Common Excavation shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation, unless provided as rock..
- B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation, excluding rock as defined below.
- C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.
- D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.

- E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.
- F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.
- G. Rock Removal: As defined in Section 31 23 18, Rock Removal.
- H. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.
- I. Unsuitable Materials: See Spoils.

### 1.3 REFERENCES

- A. Local utility standards when working within 24 inches of utility lines.

### 1.4 SUBMITTALS

- A. Section 01 33 00, Submittal Procedures: Requirements for submittals.

### 1.5 QUALITY ASSURANCE

- A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.
- B. Provide adequate survey control to avoid unauthorized over-excavation.
- C. Weather Limitations:
  - 1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (F) shall not be used as fill or backfill until material completely thaws.
  - 2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

## PART 2 PRODUCTS - Not Used

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Engineer as to the nature and extent of the differing conditions.
- B. Call Local Utility Line Information service at 811 not less than 3 working days before performing Work.
  - 1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.
- C. Identify required lines, levels, contours, and datum.
- D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

### 3.2 SITE CONDITIONS

- A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.
- B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.
- C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

### 3.3 EXISTING UNDERGROUND UTILITIES

- A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.
- B. Remove inactive or abandoned utilities from within the project grading limits.

### 3.4 PRESERVATION OF EXISTING IMPROVEMENT

- A. Protect adjacent existing structures which may be damaged by excavation work.
  1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, trees, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.
  2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Engineer.
  3. Excavated material shall not be placed adjacent to existing or proposed structures.

### 3.5 EXCAVATION

- A. General:
  1. Method of excavation shall be the Contractor's option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.

2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Engineer at no additional cost to Owner.
  3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.
  4. Provide all measures to ensure public safety.
- B. Control of Water:
1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.
  2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.
  3. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.
- D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.
1. Allow for forms, shoring, working space, granular base, topsoil, and similar items, wherever applicable.
  2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.
- E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.
1. Fill:
    - a. Subsoil Type S1, Select Native Fill, as approved for use by Engineer.
  2. Spoils:
    - a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.
    - b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.
    - c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Engineer.
- F. Shoring:
1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state, and federal laws, codes, and ordinances.

2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain, and remove such supports in accordance with applicable ordinances and safety requirements.
  3. The design, planning, installation, and removal of all sheeting accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.
- G. Slope existing banks with machine to angle of repose or less until shored.
1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.
  2. Protection of excavation side slopes:
    - a. Use excavation methods that will not shatter or loosen excavation slopes.
    - b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.
    - c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.
    - d. Excavation in rock or rocky cuts:
      - 1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.
      - 2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.
      - 3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.
    - e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.
  3. Construct slopes free of all exposed roots.
  4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.
  5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.
  6. Trim all surfaces neatly and smoothly.
- H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 05 13, Soils for Earthwork.

- I. Notify Engineer of unexpected subsurface conditions.
- J. Over-excavation for Unsuitable Foundation Conditions:
  - 1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.
  - 2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate . All material placed shall be compacted to 95 percent of maximum dry density.
  - 3. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.
- K. Rock Removal:
  - 1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.
  - 2. Notify Engineer of larger boulders and rock material encountered.
  - 3. Concrete removal, as defined herein, shall be treated as Rock Removal.
- L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

### 3.6 FIELD QUALITY CONTROL

- A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.
- B. Coordinate the visual inspection and approval of all bearing surfaces by Engineer before installing subsequent work.

### 3.7 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.
- B. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

## SECTION 32 91 13 - SOIL PREPARATION

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Preparation of subsoil.
2. Soil testing.
3. Placing topsoil.

B. Related Sections:

1. Section 31 05 13 – Soils for Earthwork
2. Section 31 22 13 - Rough Grading
3. Section 32 92 23 - Sodding

#### 1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

Test Reports: Indicate topsoil nutrient and pH levels with recommended soil supplements and application rates.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

#### 1.3 SUSTAINABLE DESIGN SUBMITTALS

A. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

1. Materials Resources Certificates:

- a. Certify source for regional materials and distance from Project Site.

B. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

1. Provide cost data for the following products:

- a. Regional products.



#### 1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with City of Thornton Construction Standards and Specifications
- B. Maintain one copy of each document on site.

#### 1.5 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate with installation of underground sprinkler system piping and watering heads.

### PART 2 PRODUCTS

#### 2.1 SOIL AMENDMENTS

- A. Composted Amendment: ' Biocomp' Class 1 non-manure based compost as supplied by A-1 Organics, Eaton, CO or approved equal, meeting the following:

- 1. Organic Matter Content > 20% and < 35%
- 2. Soluble Salts < 5 mmhos/cm
- 3. pH units 6.0 to 7.0
- 4. Nitrogen total > 0.75%
- 5. Phosphorus total > 0.5%
- 6. Potassium total > 0.25%
- 7. Calcium total > 0.8%
- 8. Magnesium total > 0.15%
- 9. Carbon to Nitrogen ratio 10:1 to 12:1
- 10. Particle size 99.8% < 9.5mm. No silt or Screened to 3/8" minus.

Apply at a rate of 6 cubic yards per 1,000 square feet for sod and planting bed areas. For native seed areas, apply at a rate of 3 cubic yards per 1,000 square feet.

If soil is compacted in the sole opinion of the Owner, additional cross directional core aeration is required until soil is deemed viable.

- B. Compost Certification Specifications:
  - 1. Composted soil amendments must be produced at a facility permitted and regulated under the State of Colorado Department of Public Health and Environment and/or the county in which the facility operates for the production of compost and soil amendments.

2. The product must be certified to have been produced in a manner that meets the US EPA 40CFR 503.13 minimum standards for pathogen destruction under a controlled, monitored, and documented process.
3. The supplier must certify that no supplemental nitrogen or other chemicals have been added to the compost to alter or enhance the results of the laboratory analysis, unless specifically requested by the design architect.
4. The contractor must supply a letter of certification from the manufacturer which confirms that the product being supplied has met the referenced requirements and that supporting documentation exists and is available for inspection (if requested).

## 2.2 SOIL MATERIALS

- A. Topsoil: As specified in Section 31 05 13, Soils for Earthwork.

## 2.3 FERTILIZER

- A. Commercial Fertilizer:

1. Native Seeded Areas:

- a. Commercial fertilizer as 1200 lb/Ac if high organic results up to 1800 lbs/Ac if low organic results Biosol min 800lb/Ac topically applied after drilling (Pawnee Buttes Seed Company, Rocky Mountain Bio Products or equal).
- b. Humate at minimum 400 lb/Ac or ½ the amount/Ac Biosol

2. Sodded Lawns:

- a. Commercial granular fertilizer as 18-46-0 at the rate of 3 lb/1000 square feet with the following composition by weight: Nitrogen, eighteen percent (18%) and phosphoric acid (P205), forty-six percent (46%). These elements may be organic, inorganic, or a combination of the two, and shall be measured according to the methods of the Association of Official Chemists.

## 2.4 HERBICIDE

- A. Roundup by Monsanto: Apply according to manufacturer's instructions using certified applicators.

## 2.5 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Testing, inspection, and analysis requirements.

- B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- C. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.
- D. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. General: Verify that existing site conditions are as specified and indicated before beginning work under this section.
  - 1. Grades: Inspect to verify rough grading is within + 0.1 foot of grades indicated and specified.
  - 2. Damaged Earth: Inspect to verify that earth rendered unfit to receive planting due to concrete water, mortar, limewater or any other contaminant dumped on it has been removed and replaced with clean earth from a source approved by the Owner's Representative.
- C. Unsatisfactory Conditions: Report in writing to General Contractor with copy to Owner's Representative.
- D. Acceptance: Beginning of installation means acceptance of existing conditions by installer.

### 3.2 PREPARATION OF SUBSOIL

- A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles, and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.
- C. Scarify subsoil to depth of **3 inches** where topsoil is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted sub-soil.

### 3.3 INSTALLATION

#### A. Fine Grading in all Landscape Areas:

1. Do fine grading for areas immediately prior to planting.
2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.
3. Establish finish grades to within 0.05 foot of grades indicated. The intent of this spec is to prevent 'bird baths' or ponding.
4. Finish grade to be below edge of pavement prior to sodding, seeding or planting.
  - a. Sodded Areas: Allow 1.5" for sod.
  - b. Shrub Beds: Allow 4" for mulch.
  - c. Seeded Areas: Allow 1" for seed.
5. Noxious weeds or parts thereof shall not be present in the surface grade prior to landscaping.
6. Compaction of Surface Grade Prior to Landscape Installation: Firm, but not hard (80% standard Proctor density within 2% optimum moisture).
7. Prior to acceptance of grades, rake to smooth, even surface free of debris, clods, rocks, and vegetable matter greater than 1". Native seed areas should not be raked smooth but left in a uniform condition.
8. Sodded Lawns: Apply nitrogen fertilizer, at the rate specified, after fine grading and prior to sodding.
9. Restore planting areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

#### B. Soil Amendment

1. Limit preparation to areas which will be planted promptly after preparation.
2. Clean topsoil of stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
3. Sodded Lawns: Spread soil amendments and phosphate at the rate specified after topsoil (if specified) is spread. Rake gently to meet lines, grades and elevations shown, allowing for natural settlement.

4. Native Seed: Spread soil amendments and fertilizer at the rate specified after topsoil (if specified) is spread. Rake gently to meet lines, grades and elevations shown, allowing for natural settlement.

C. Topsoil

1. Spread topsoil to minimum depth of 6 inches over area to be seeded. Rake until smooth.
2. Place topsoil during dry weather and on dry unfrozen subgrade.
3. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
4. Grade topsoil to eliminate rough, low, or soft areas, and to ensure positive drainage.
5. Install edging at periphery of seeded areas in straight lines to consistent depth.

3.4 NOTIFICATION AND INSPECTION

- A. Inspection: Provide notice to Owner's Representative requesting inspection at least 7 days prior to anticipated date of completion.
- B. Deficiencies: Owner's Representative will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Owner's Representative for final inspection.

3.5 CLEANING

- A. General: Remove debris and excess materials from site. Clean out drainage inlet structures. Clean paved and finished surfaces soiled as a result of work under this section, in accordance with direction given by Owner's Representative.

3.6 PROTECTION

- A. General: Provide and install barriers as required to protect completed areas against damage from pedestrian and vehicular traffic until acceptance by Owner. Contractor is responsible for malicious destruction caused by others.

END OF SECTION

## SECTION 32 92 23 - SODDING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Preparation of subsoil.
  - 2. Placement of topsoil.
  - 3. Fertilization.
  - 4. Sod installation.
  - 5. Maintenance.
- B. Related Sections:
  - 1. Section 32 05 13 - Soils for Earthwork
  - 2. Section 32 91 13 - Soil Preparation

#### 1.2 DEFINITIONS

- A. Weeds: Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" and drawing designations for planting soils.

#### 1.3 REFERENCE STANDARDS

- A. ASTM International:
  - 1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
- B. Turfgrass Producers International:
  - 1. TPI - Guideline Specifications to Turfgrass Sodding.

#### 1.4 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

- B. Coordinate Work of this Section with installation of underground sprinkler system piping and watering heads by others.

#### 1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Certification of grass seed.
  - 1. Certification of each seed mixture for turfgrass sod.
  - 2. Load tickets.
- C. Product certificates.
- D. Seed mixture for each product, including application rates and ratios.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 2. Pesticide Applicator: State licensed, commercial.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

### PART 2 PRODUCTS

#### 2.1 TURFGRASS SOD

- A. Turfgrass Sod: Certified, Approved, Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Sod: Provide strongly rooted sod, not less than two years old, free of weeds and undesirable native grasses and machine cut to pad thickness of 3/4" (+ 1/4"), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant).

1. Provide sod of uniform pad sizes with maximum 5% deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10% of pad will be rejected. No netting allowed.
  2. Provide large rolls of sod for areas over 4,000 SF.
- C. Turfgrass Species Characteristics:
1. Provide locally grown sod composed of the following: Four varieties of bluegrass including one Elite drought tolerant, one Elite shade tolerant, one aggressive and one dense, and Perennial Rye Pennfine 10%.

## 2.2 FERTILIZERS

- A. Granular fertilizer 18-46-0 at the rate of 3 lb/1000 SF with the following composition by weight: Nitrogen, eighteen percent (18%) and phosphoric acid (P205), forty-six percent (46%). These elements may be organic, inorganic, or a combination of the two, and shall be measured according to the methods of the Association of Official Chemists.
- B. Apply commercial nitrogen fertilizer as specified in Section 32 91 13. Apply after fine grading and prior to compaction.
- C. Lightly water to aid the breakdown of fertilizer.
- D. Apply fertilizer within 48 hours before laying sod.

## 2.3 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that prepared soil base is ready to receive Work of this Section.

### 3.2 INSTALLATION

- A. Area Preparation:
  1. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."
  2. Reduce elevation of planting soil to allow for soil thickness of sod.



3. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
  4. Before planting, obtain Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- B. Laying of Sod:
1. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
  2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
    - a. Lay sod across slopes exceeding 1:3.
    - b. Anchor sod on slopes exceeding 3:1 with wood pegs spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
  3. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.
  4. Rolling: When soil and sod are moist, roll sod lightly as soon as possible after it is laid. Delay rolling until just before the second watering.
  5. Topsoil: Add along exposed edges to match adjacent grade. Feather topsoil out approximately 1 ft. from edge of sod.
  6. Drainage: Assure finished areas of sod are such that positive drainage of storm and irrigation water will occur and ponding of water will be minimized.

### 3.3 MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf until Initial Acceptance by Owner, as specified in the Appendix of these specifications. Roll, regrade, and replant bare or eroded areas and mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Mow to maintain a grass height of 2½-3 inches.
- C. Minimum of three (3) weekly mowings or 21 days, whichever is longest, and including one establishment fertilization application.

- D. Apply fertilizer after initial mowing (within approximately 20 days after sodding), when grass is dry, using fertilizer that will provide actual nitrogen of at least 1 lb/1000 SF, 20-10-5 plus iron and 8% sulfur fertilizer (50% sulfur coated urea)

Continue fertilizer applications every 30 days thereafter at the rate of ½ lb actual nitrogen per 1000 SF until Initial Acceptance of project--in March, April, May, June, August, September, October and November (no fertilizer in July, December, January, and February).

#### 3.4 TURF ACCEPTANCE

- A. Turf installations shall meet the following criteria as determined by Owner:
  - 1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored green typical of the improved turf types installed, viable turf has been established, free of weeds, open joints, bare, dead or discolored spots larger than six (60 inches in any dimension and surface irregularities. No standing water and substantially (less than 5%) free of weeds.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.
- C. Sod will be considered established when fully rooted and capable of healthy growth with normal 1½" per week post-establishment watering schedules.

END OF SECTION

## SECTION 33 13 00 - TESTING OF WATER UTILITY PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes hydrostatic pressure testing testing of water systems piping, fittings, valves, and domestic water services.
- B. Section Includes:
  - 1. Pressure testing water distribution and transmission piping systems and appurtenances.
  - 2. Testing and reporting of results.
- C. Related Requirements:
  - 1. Section 40 05 13 – Common Work Results for Process Piping

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
  - 1. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
  - 2. AWWA C605 - Underground Installation of PVC and PVCO Pressure Pipe and Fittings

#### 1.3 PERFORMANCE AND DESIGN REQUIREMENTS:

- A. Regulatory requirements
  - 1. Conform to applicable code or state regulation for performing the work of this Section

#### 1.4 SUBMITTALS

- A. The following list of submittals are to be made under this section and in accordance with the provisions of Sections 01 33 00 – Submittal Procedures, and 01 45 00 – Quality Control. At the time the first submittal is made under this section, include the addresses and phone numbers of nearest manufacturer's representative
  - 1. Provide a copy of any pertinent Drawings, this specification section and all related Sections and with all addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements
- B. Product Data: Submit procedures, proposed chemicals, and treatment levels.

- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Pipeline Testing Plan: To be submitted for review and approval by the Engineer a minimum of 1 month before testing is to start. As a minimum, the plan shall include the following:
  - 1. Testing schedule.
  - 2. Hydrostatic Testing Plan:
    - a. Narrative of the proposed process.
    - b. Proposed equipment to be used.
    - c. Disposal location for excess water used to fill mains.
  - 3. Proposed testing locations.
  - 4. Proposed plan for water conveyance, including flow rates.
  - 5. Proposed plan for water control.
  - 6. Proposed plan for water disposal, including flow rates. Include proposed plan for dechlorination of disinfection water, including discharge points.
  - 7. Proposed measures to be incorporated in the project to minimize erosion while discharging water from the pipeline.

1.5 QUALITY ASSURANCE

- A. Perform Work according to AWWA C651 and C652.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. All temporary thrust restraint and equipment and facilities required for hydrostatic testing will be considered incidental.
- B. As a minimum, furnish the following equipment and materials for the testing:

Amount	Description
2	Graduated containers approved by the Engineer.
1	Hydraulic pump approved by the Engineer with hoses, valves, and fittings as needed and required for the testing of the facilities.
2	Pressure gauges with pressure range at least 120 percent greater than the required maximum test pressure with graduations in 2 pounds per

	square inch (psi) increments. Gauges shall have been calibrated with 90 days of pressure testing.
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PART 3 EXECUTION

3.1 HYDROSTATIC TESTING OF WATER PIPING

- A. Make all necessary provisions for conveying water to the points of use and for the disposal of test water.
- B. No section of the pipeline shall be hydrostatically tested until backfill has been placed, compacted, and compaction tests results have been submitted to and approved by the Engineer and all field-placed concrete or mortar has attained full strength.
  - 1. At the Contractor’s option, early strength concrete may be used when the full-strength requirements conflict with schedule requirements.
  - 2. All such substitutions and installations shall be approved by the Engineer prior to installation.
- C. Provide 72-hour notification to the Engineer and Owner prior to conducting hydrostatic testing.
  - 1. Provide coordination and scheduling required for the Owner and Engineer to witness and provide necessary labor for operating Owner’s existing system during hydrostatic testing and disinfecting procedures.
  - 2. The Contractor shall not operate any part of the existing water systems.
- D. Pipe Filling:
  - 1. Fill pipes slowly from the lowest elevation to highest point along test section with potable water.
  - 2. Take all required precautions to prevent entrapping air in the pipes.
  - 3. Allow for natural absorption of water by the lining of the pipe to occur.
  - 4. Apply specified test pressure by pumping.
- E. Testing of Mains:
  - 1. In accordance with AWWA C600 or C900.
  - 2. General:

- a. Tests shall be conducted under a hydrostatic test pressure of a minimum **150** psi or 50 psi above working pressure, whichever is greater.
- b. In no case shall the test pressure exceed the rated working pressure for any joint, thrust restraint, valve, fitting, or other connected appurtenance of the test section.
- c. Testing shall be performed by applying the specified test pressure by pumping.
- d. Once the test pressure has been attained, the pump shall be valved off.
- e. The test will be conducted for a 2-hour period with the allowable leakage not to exceed the value as calculated per the Allowable Leakage formula below.
- f. During the test period, there shall be no appreciable or abrupt loss in pressure.
- g. The Owner shall not be held responsible for water tightness of its valves on existing facilities. If existing valves leak, the Owner shall assist in reducing the influx of water, but the Contractor must use methods at his own disposal to work with the resulting leakage.

3. Allowable Leakage:

- a. Maximum permissible leakage loss from water mains shall be in accordance to AWWA C601 and City of Thornton Standards and Specifications Table 200-3, Maximum Permissible Leakage Loss from Water Mains.
- b. Mechanical or Push-on Joints: Pipe, fittings and valves with rubber gasketed joints shall have a measured loss not to exceed the rate given in the following Allowable Leakage formula:

$$AL = \frac{LD(P)^{1/2}}{148,000}$$

In the above formula:

- AL = Allowable leakage, in gallons per hour
- L = Length of pipe tested, in feet
- D = Nominal diameter of pipe, in inches
- P = Average test pressure during the leakage test, in pounds per square inch.

4. Maintaining Pressure:

- a. During the test period, operate the pump as required to maintain pressure in the pipe within 5 psi of the specified test pressure at all times.

- b. At the end of test period, operate the pump until the specified test pressure is again obtained.
    - 1) The pump suction shall be in a clean, graduated barrel, or similar device or metered so that the amount of water required to restore the test pressure may be accurately measured.
    - 2) Sterilize this makeup water by adding chlorine to a concentration of 25 milligrams per liter (mg/L).
  - c. The Engineer will determine the quantity of water required to maintain and restore the required pressure at the end of the test period.
  - d. Each hour's loss stands on its own and will not be averaged.
5. Defects, Leakage, Failure:
- a. If the test reveals any defects, leakage in excess of the allowable, or failure, furnish all labor, equipment, and materials required to locate and make necessary repairs.
  - b. Correct any visible leakage regardless of the allowable leakage specified above.
  - c. All leaks shall be repaired in a manner acceptable to the Engineer.
  - d. The testing of the line shall be repeated until a test satisfactory to the Engineer has been achieved.

END OF SECTION

## SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

This Section applies to the furnishing and installation of piping inside a building, structure, enclosure piping and miscellaneous yard piping.

##### A. Related Sections:

1. Section 33 13 00, Testing of Water Utility Piping

#### 1.2 REFERENCE STANDARDS

##### A. American Society of Mechanical Engineers (ASME):

1. ASME B1.20.1 Pipe Threads, General Purpose (inch)
2. ASME A13.1 - Scheme for the Identification of Piping Systems.
3. ASME B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy, and other Special Alloys
4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.
5. ASME B31.3 - Process Piping.
6. ASME B31.9 - Building Services Piping.

##### B. ASTM International (ASTM):

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile.
3. ASTM A325 - Specification for High-Strength Bolts for Structural Steel Joints.
4. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
6. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
7. ASTM D792 - Test Methods for Specific Gravity and Density of Plastics by Displacement.
8. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.



10. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  11. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.
  12. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  13. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
  14. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- C. American Water Works Association (AWWA):
1. AWWA C200 - Steel Water Pipe - 6 In. (150 mm) and Larger.
  2. AWWA C207 - Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
  3. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
  4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
  5. AWWA C510 - Double Check Valve Backflow Prevention Assembly.
  6. AWWA C511 - Reduced-Pressure Principal Backflow Prevention Assembly.
  7. AWWA C606 - Grooved and Shouldered Joints.
  8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
- D. American Welding Society (AWS):
1. AWS D1.1 - Structural Welding Code.
- E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry:
1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- F. NSF International (NSF):
1. NSF 61 - Drinking Water System Components - Health Effects.
  2. NSF 372 - Drinking Water System Components - Lead Content.

### 1.3 COORDINATION

- A. Coordinate installation of specified items with installation of valves and equipment.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit Manufacturer catalog information for each product specified.
- C. Shop Drawings:
  - 1. Identification:
    - a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
    - b. Comply with ASME A13.1.
  - 2. Provide all necessary dimensions and details on pipe joints, restraints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists.
  - 3. Provide detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, couplings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.
- D. Manufacturer's Statement: Certifying pipe fabrication and products meet or exceed specified requirements.
- E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS and ASME qualification within previous 12 months.
- F. Manufacturer Instructions: Submit special procedures and setting dimensions.
- G. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of piping appurtenances.
- B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

#### 1.6 QUALITY ASSURANCE

- A. Drawings:
  - 1. Piping layouts shown in the Drawings are intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.
- B. Inspection:

1. All pipe shall be subject to inspection at the place of manufacture.
  2. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- C. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.

#### 1.7 MATERIAL DELIVERY, STORAGE, AND INSPECTION

- A. Inspection:
1. Accept materials on Site in Manufacturer's original packaging and inspect for damage.
  2. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition.
- B. Storage:
1. Store materials according to Manufacturer instructions.
  2. Store materials off the ground, to provide protection against oxidation caused by ground contact
- C. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  3. Provide additional protection according to Manufacturer instructions.
- D. All defective or damaged materials shall be replaced with new materials.

#### 1.8 EXISTING CONDITIONS

- A. Field Measurements:
1. Verify field measurements prior to fabrication.
  2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 GENERAL

- A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.
  - 1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.
  - 2. All brass in contact with potable water shall comply with ASTM B584.
- B. Unless specified otherwise or indicated differently in the Drawings, all piping systems and process piping materials shall be as listed in the table below or as shown on the Drawings:

Service	Material
Exposed ≥ 4”	Class 52 Ductile Iron
Buried ≥ 4”	Class 52 Ductile Iron or C900 PVC
Submerged/Buried < 4”	Stainless Steel - Type 316 Schedule 40 Threaded - ASTM A 312 Fittings Welded or Threaded
Exposed < 4”	Brass - ASTM B 43, Fittings - Bronze - ASTM B 62 Threaded - ANSI/ASME B 16.15
Buried < 4”	Copper Tubing - ASTM B88 Type K Soft / Fittings - Wrought Copper - ANSI B16.22, Joints-Soldered

2.2 DUCTILE IRON PIPE AND FITTINGS

- A. Centrifugally cast, conforming to AWWA Standard C151.
- B. Coating: Asphaltic exterior coating in accordance with AWWA Standard C151
- C. Pipe Mortar Lining: Shop-applied NSF 61 cement mortar lining, smoothed finish, complying with AWWA C104.
- D. Pipe Thickness Class:
  - 1. Comply with AWWA C151.
  - 2. Class 52, unless shown to be greater in the Plans.
    - a. The Contractor shall be aware ductile iron piping with thickness class greater than Class 52 may have long fabrication and supplier lead times. The Contractor shall be responsible for coordinating product submittal and delivery times accordingly such as not to delay construction.
- E. Flanged Joints:
  - 1. Flat faced, complying with AWWA C111 and C115, unless otherwise specified.

2. Bolt hole drilling according to ASME/ANSI B16.1, Class 125, or ASME/ANSI B16.1, Class 250, where specified. Flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.
3. The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain mating pipe, valve, and fitting flanges match in bolt pattern.
4. Pressure rating of flange joints shall not exceed the rating of the pipe or fitting of which they are a part, and the maximum pressure rating of the joint shall be 250 psi.
5. Flange joint connections shall not be exposed to test pressures greater than 1-1/2 times their rated working pressure.
6. Gaskets:
  - a. Full faced, composed of synthetic rubber and 1/8-inch-thick conforming to ASME B21.1 and AWWA C111.
  - b. Ring gaskets will be permitted only where specifically noted in the Drawings and Specifications.
  - c. Gaskets for flanged joints shall be as follows:
    - 1) Pipe sizes between 6-inch and 24-inch diameter, service pressures of 150 psi or greater shall be Garlock 3760-U or equal.
    - 2) Pipe sizes 4-inch diameter and under, service pressures of 150 psi or greater shall be Garlock Linebacker or equal.
    - 3) All pipe sizes with service pressures of 150 psi or less shall be Garlock 98206 or equal.
  - d. Gaskets for insulating flanged joints shall be as follows:
    - 1) Full faced, conform to ANSI 16.21.
    - 2) Material: Non-asbestos.
    - 3) Suitable for operating and test pressures of the pipe system.
    - 4) Manufacturer:
      - a) Garlock PSI Linebacker—manufactured by GPT-or equal.

## 2.3 COPPER PIPE AND FITTINGS

### A. Description:

1. Seamless; ASTM B88.
2. Type:
  - a. Type L, hard drawn.

b. For pipe under floor slabs, underground or cast in concrete: Type K, annealed, seamless.

B. Joints:

1. Compression.
2. Manufacturer: Mueller Model 110 or equal

C. Dissimilar Metals: See Dielectric Unions specified herein.

#### 2.4 BRASS PIPE AND FITTINGS

A. Pipe: ASTM B43, chrome plated.

B. Fittings:

1. ASTM B584, brass.
2. ASTM B16.15.

C. Joints:

1. Mechanical compression.
2. Threaded: Tapered and smooth threads, ASME [B1.20.1] and ASTM B43.

D. Dissimilar Metals: See Dielectric Unions specified herein.

#### 2.5 POLYVINYL CHLORIDE (PVC) WATER PIPE AND FITTINGS

A. PVC Pipe and Fittings:

1. Four-inch diameter and smaller:
  - a. Pipe: ASTM D1785, Schedule 40.
  - b. Fittings: ASTM D2466, Schedule 40.
  - c. Joints: Socket, solvent-welded, ASTM D2855.
  - d. Materials: ASTM D1784, minimum cell classification 12545-C.

#### 2.6 FLEXIBLE TUBING

A. Polyethylene thermoplastic tubing:

1. Standard weight, conforming to ASTM D1248 Type 1, Class A, Category 4, Grade E5.

#### 2.7 FLEXIBLE COUPLINGS

A. Description:

1. Sleeve-type, couplings. Comply with AWWA C219.

2. Minimum design pressure rating: 150 pounds per square inch (psi).
  3. Middle Ring: As required for coupling based upon connecting pipe materials, steel, or ASTM A536, ductile iron.
  4. Followers: As required for coupling based upon connecting pipe materials, steel, or ASTM A536, ductile iron.
  5. Gaskets:
    - a. Material: Buna-N.
    - b. Comply with ASTM D2000.
  6. Bolts:
    - a. Buried: Steel.
    - b. Submerged: Stainless steel.
  7. Center Pipe Stop: Required where shown on the Drawings.
- B. Finishes:
1. Buried Couplings, Bolts: Factory epoxy coated.
- C. Manufacturers:
1. For ductile iron:
    - a. Dresser, Style 38.
    - b. Romac, Model 501.
    - c. Smith-Blair.
  2. For PVC pipe:
    - a. Romac, Model 501 or equal.
  3. For flanged steel and ductile pipe:
    - a. Dresser, Style 128 or equal.

## 2.8 RESTRAINED FLANGE ADAPTERS FOR DUCTILE IRON PIPE

- A. Description:
1. ASTM A536, ductile iron.
  2. Flange bolt circles compatible with ANSI/AWWA C115/A21.15.

3. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges.
4. Capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6-inch gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
5. Safety factor of 2:1 minimum.
6. Manufacturer:
  - a. EBAA Iron, Series 2100 Megaflange or equal.

## 2.9 FLANGED INSULATING JOINTS

- A. Set shall include a full faced gasket, a full-length insulating sleeve for each flange bolt, and two insulating washers and two steel washers for each bolt.
  1. Gaskets:
    - a. Full-face, comply with ASME 16.21.
    - b. Non-asbestos and non-phenolic compressed sheet packing with nitrile rubber binder.
    - c. Manufacturer: Garlock, Style 3505, or equal.
  2. Insulating sleeves:
    - a. G-10 glass epoxy.
    - b. Extend the full width of both flanges, except where one flange hole is threaded where the sleeve shall extend through one flange and the gasket.
  3. Insulating washers:
    - a. G-10 glass epoxy.
    - b. One-eighth-inch thickness.
  4. Washers:
    - a. Buried: Cadmium plated steel.
    - b. Submerged: Stainless steel.
- B. The complete assembly shall have an ANSI/AWWA pressure rating equal to or greater than that of the flanges between which is installed.
- C. After assembly, the joint shall be tested for continuity. Electrical resistance between flanges and between each bolt and each flange shall be not less than 100,000 ohms.



## 2.10 INSULATING UNION

### A. Description:

1. Material: Galvanized malleable iron with a ground joint.
2. Iron pipe threads: Conform to ANSI B2.1.
3. Insulations: Nylon, bonded, and molded onto the metal body.
4. Union: Rated for the operating and test pressures of the pipe system.
5. Joint connections to copper alloy pipe and tube shall be copper solder or threaded brass ground joints.
6. Isolation Barrier: Impervious to water.

## 2.11 DISMANTLING JOINT

### A. Description:

1. Comply with AWWA C219, where applicable.
2. Self-contained flanged restrained joint fitting, including both flanged components and sufficient harness bars to withstand the imposed thrust.
3. Design: No part of the restraint system extends outside the flange diameter. The internal bore shall match that of the pipe system.
4. Dismantling joints will allow for a minimum of 2 inches of longitudinal adjustment.
5. Furnish as a complete assembly consisting of spigot piece, flange adaptor, tie bars, and gasket.
6. The gasket seal and compression stud and nut arrangement shall be independent of the tie rod restraint system. Tie Rod diameter shall be compatible with the corresponding bolt diameter of the mating flange. The Tie Rod restraint system shall be capable of withstanding the full pressure thrust that the pipe system can develop at no more than 50 percent of the yield strength of tie rod material.
7. Pressure Rating:
  - a. Determined by the flange configuration, and all commonly used flanges shall be available.
  - b. Design pressure rating shall be equal to or greater than the mating flanges.
  - c. Dismantling joints will be specially fabricated to accommodate pressure requirements with ANSI B16.5 or ANSI B16.47 300-pound class flanges, depending on size of dismantling joint.
8. Lining and Coating:

- a. Shop-applied fusion bonded epoxy coating applied by fluidized bed method, complying with the requirements of NSF 61 and AWWA C550 as applicable.
  - b. As an alternative, a shop-coat primer suitable for field applied coatings can be supplied.
- 9. Flanges: Flat-faced, rated to pressure requirements as shown on the Drawings.
  - a. Where design pressure is greater than 300 psi, flanges shall conform to ASME B16.5 and ASME B16.47 300-pound class.
- B. Materials:
  - 1. Spigot piece: Steel, ASTM A283 Grade C.
  - 2. Flange adaptor:
    - a. Up to 12-inch diameter: Ductile iron, ASTM A536 Grade 65-45-12.
    - b. Above 12-inch diameter: Steel, ASTM A283 Grade C.
  - 3. Tie bars: ASTM A193 Grade B7 threaded rod with rolled threads.
  - 4. Gasket: EPDM Grade E.
  - 5. Nuts, Bolts, and Washers: Type 304 stainless steel.
- C. Manufacturer:
  - 1. Romac or equal.

## 2.12 PIPE SUPPORTS

- A. Floor Support for Pipe:
  - 1. Flanged Pipe Support:
    - a. Construction:
      - 1) Adjustable vertical pipe support, flange plate, extension pipe from base cup to top collar cup with threaded stud.
      - 2) Bolts directly to flange.
      - 3) Anchorable base plate.
    - b. Material: Steel, comply with ASTM A36.
    - c. Finish: Corrosion resistant, electro-galvanized, or prime coated.
    - d. Manufacturers:
      - 1) Standon - Model S89.

2. Cradle Pipe Support:
  - a. Construction:
    - 1) Adjustable vertical pipe support with saddle strap, extension pipe from base cup to top collar cup with threaded stud.
    - 2) Anchorable base plate.
  - b. Material: Steel, comply with ASTM A36.
  - c. Finish: Corrosion resistant, electro-galvanized, or prime coated.
  - d. Manufacturers:
    - 1) Standon - Model S92.

### 2.13 PIPE PENETRATIONS

- A. Sleeves for Pipes through Walls and Floors:
  1. Material: Galvanized steel.
  2. Thickness: Schedule 40.
  3. Inside surface of all wall sleeves shall be coated with coal-tar.
  4. Annular space between penetrating pipe and wall sleeve shall be filled with an approved permanently flexible sealant.
  5. Diameter of wall sleeve shall be as shown in the Drawings.
- B. Mechanical Sleeve Seals:
  1. Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
  2. Manufacturer: Link-Seal or equal.

### 2.14 PIPE COATINGS

- A. Industrial coating systems shall be as follows
  1. Coating System 100
    - a. Location -- Exposed, unprimed, non-galvanized, nonsubmerged metal surfaces, both interior and exterior including piping, and structural steel.
    - b. Surface Preparation -- As specified herein.
    - c. Coating System -- Apply prime coat and topcoat, 4.0-6.0 mils each coat of Tnemec Series 66-2 Hi-Build Epoxoline, or equal.

## 2. Coating System 101

- a. Location -- Exposed metal surfaces, shop primed, both interior and exterior including piping, railings, ladders, steel doors, and any other metal items not otherwise specified.
  - b. Surface Preparation -- As specified herein.
  - c. Coating System -- Apply shop prime coat 3.0 mils DFT Tnemec Series 90-97 Tnemec-Zinc, one coat 4.0 - 6.0 mils DFT Tnemec Series 66 Hi-Build Epoxoline, and 3.0 - 4.0 mils DFT of Tnemec Series 175 Endura Shield, or equal.
- B. Pipes, fittings, and accessories shall be painted with a Safety Green Color, PC855.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill, and encasement, to provide a functional installation.
- B. Pipe shall be installed in accordance with good trade practice. The methods employed in handling and placing of pipe, fittings, and equipment shall be such as to insure that after installation and testing they are in good condition. Should damage occur to the pipe, fitting or equipment, repairs satisfactory to the Engineer shall be made.

### 3.2 INSTALLATION

- A. Buried Piping Systems:
  1. Establish elevations of buried piping with not less than 4.5 feet of cover.
  2. Remove scale and dirt from inside of piping before assembly, as may be required.
  3. Install pipe to accurate lines, elevations, and grades as shown on the Drawings.
  4. Where grades are not shown, pipe shall be laid to grade between control elevations shown on the Drawings.
  5. Place bedding material at trench bottom to provide uniform bedding for piping.
  6. Level bedding material in one continuous layer not exceeding 6 inches compacted depth.
  7. Install pipe on prepared bedding.
  8. Route pipe in straight line.
  9. Install pipe to allow for expansion and contraction without stressing of pipe or joints.

10. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.
  11. All buried non-ferrous piping shall be installed with detectable tracer tape.
    - a. Tape shall be buried 12 inches above the top of the pipe or as recommended by Manufacturer.
    - b. Tape shall be continuous and labeled the same as the piping system.
- B. Interior Piping Systems:
1. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as specified in Section 09 90 00, Painting and Coating.
  2. Install water piping according to ASME B31.9.
  3. Install unions downstream of valves and at equipment or apparatus connections.
  4. Install brass male adapters each side of valves in copper piped system, solder adapters to pipe.
- C. Pipe Supports and Hangers
1. Install pipe supports according to MSS SP-58 and ASME B31.10.
  2. All pipe shall be secured in place by use of blocking, hangers, brackets, clamps or other approved methods, and the weight thereof shall be carried independently of pump casings or equipment.
  3. Special hangers and supports are shown on the Drawings.
  4. The Contractor shall be responsible for determining the location of and providing all additional supports.
  5. Hanger supports shall be as noted below with at least one support adjacent to the joint for each length of pipe, at each change in direction and at each branch connection. Sufficient hangers shall be provided to maintain proper slope without sagging. Support spacing shall not exceed Manufacturer's recommendations, nor as listed below.

<u>Pipe</u>	<u>Maximum Support Spacing (Feet)</u>
Cast or Ductile Iron	
Under 4 inches	6
4 inches and Over	12
Stainless Steel and Galvanized Iron	
Under 1-1/2 inches	4
1-1/2 inches to 4 inches	6
Over 4 inches	12
Copper Pipe	6

6. Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment as well as to support the weight of the piping and contents unless other vertical support is shown, but in no case shall be more than 12 feet.
7. Provide adjustable hangers for all pipes, complete with adjusters, swivels, rods, etc. Size hangers to clear insulation and guide where required, as well as support piping. All rigid hangers shall provide a means of vertical adjustment after erection. Hanger rods shall be machine threaded. Continuous threaded rods will not be allowed.
8. Clevis or band-type hangers (B-Line FIG B3100) or equal shall be provided as required. Strap hangers not permitted.
9. Provide floor stands, wall bracing, concrete piers, etc., for all lines running near the floors or near walls and which cannot be properly supported or suspended by the walls or floors. Pipelines near concrete or masonry walls may also be hung by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.
10. Equipment shall be positioned and aligned so that no strain shall be induced within the equipment during or subsequent to the installation of pipework.
11. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

D. Pipe Penetrations:

1. Exterior Watertight Entries: Seal with mechanical sleeve seals or grout, as shown in the Drawings.
2. Whenever a pipeline of any material terminates at or through a structural wall or floor, install piping or sleeve in advance of pouring of concrete required for the particular installation.
3. Plastic pipe shall not be cast in concrete or masonry walls.
4. Set sleeves in position in forms and provide reinforcing around sleeves.
5. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
6. Extend sleeves through floors 1-inch above finished floor level and caulk sleeves.
7. Pipe other than concrete, to be cast in water-bearing walls or more than 4 feet below grade shall have seep rings.
8. All buried piping entering structures shall have a flexible connection installed less than 2 feet outside the structure line or as close to the wall as practical.

### 3.3 CLEANING, TESTING, AND DISINFECTION

- A. Testing and Disinfection: Piping shall be hydrostatically tested and flushed, as specified in Section 33 13 00, Testing of Water Utility Piping.

END OF SECTION

## SECTION 40 05 51 – COMMON REQUIREMENTS RESULTS FOR PROCESS VALVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes basic materials and methods related to valves commonly used for process systems, including pump stations, utility vaults, and water and wastewater treatment. This Section is to be used in conjunction with 40 05 51.15, Gate Valves and Section 40 05 51.24, Check Valves.
- B. Section Includes:
  - 1. Valves.
  - 2. Valve actuators.
- C. Related Sections
  - 1. Section 40 05 13, Common Work Results for Process Piping
  - 2. Section 40 05 51.15, Gate Valves
  - 3. Section 40 05 51.24, Check Valves
  - 4. Section 40 05 78, Miscellaneous Valves

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
  - 1. AWWA C504 - Rubber-Seated Butterfly Valves, 3 In. Through 72 In.
  - 2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
  - 3. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
  - 4. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
- B. ASTM International (ASTM):
  - 1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
  - 1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.
- D. NSF International (NSF):



1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

### 1.3 COORDINATION

- A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
  1. Submit Manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.
  2. Submit valve cavitation limits.
  3. Submit Manufacturer data for actuator with model number and size indicated.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.
- E. Lining and coating data.
- F. Valve Labeling Schedule: Indicate valve locations and nametag text.
- G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves and actuators.
- B. Operation and Maintenance Data: Submit information for valves.

### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts:
  1. Furnish one set of Manufacturer's recommended spare parts.
- B. Tools:
  1. Furnish special wrenches and other devices required for Owner to maintain equipment.
  2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

## 1.7 QUALITY ASSURANCE

- A. Cast Manufacturer's name, pressure rating, size of valve, and year of fabrication into valve body.
- B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.
- C. Maintain clearances as indicated on Drawings.
- D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.
- E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- B. Store materials according to Manufacturer instructions.
  - 1. Store materials in areas protected from weather, moisture, or other potential damage.
  - 2. Do not store materials directly on ground.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
  - 3. Provide additional protection according to Manufacturer instructions.
- D. Handle products carefully to prevent damage to interior or exterior surfaces.
- E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

## 1.9 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.
  - 1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.
  - 2. All brass in contact with potable water shall comply with ASTM B584.

### 2.2 VALVES

- A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required and shown in the Drawings.
- B. Operation:
  - 1. Open by turning counterclockwise; close by turning clockwise.
  - 2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- C. Valve Construction:
  - 1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
- D. Connecting Nuts and Bolts: Stainless steel.

### 2.3 RESILIENT-SEATED GATE VALVES

- A. As specified in Section 40 05 51.15, Gate Valves.

### 2.4 VALVE ACTUATORS

- A. All valves shall be furnished with manual actuators, unless otherwise indicated in the Drawings.
- B. Valves in sizes up to and including 4 inches in diameter shall have handwheel actuators of the Manufacturer’s best standard design.
- C. Actuators shall be sized for the valve design pressure in accordance with AWWA C504.
- D. Comply with AWWA C541 and C542, where applicable.
- E. Provide gear and power actuators with position indicators.
- F. Gear-Assisted Manual Actuators:
  - 1. Provide totally enclosed gears.

2. Maximum Operating Force: 60-pound-force (lbf).
  3. Bearings: Permanently lubricated bronze.
  4. Packing: Accessible for adjustment without requiring removal of actuator from valve.
- G. Handwheel:
1. Furnish permanently attached handwheel for emergency manual operation.
  2. Rotation: None during powered operation.
  3. Permanently affix directional arrow and cast OPEN or CLOSE on handwheel to indicate appropriate direction to turn handwheel.
  4. Maximum Operating Force: 60 lbf.

## 2.5 SOURCE QUALITY CONTROL

- A. Testing: Test valves according to Manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that piping system is ready for valve installation.

### 3.2 PREPARATION

- A. Access: All valves shall be installed to provide easy access for operation, removal, and maintenance and to avoid conflicts between valve operators and structural members or handrails.
- B. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the Contractor to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.

### 3.3 INSTALLATION

- A. Install valves, actuators, extensions, and accessories according to Manufacturer instructions.
- B. Firmly support valves to avoid undue stresses on piping.
- C. Coat studs, bolts, and nuts with anti-seizing lubricant.
- D. Clean field welds of slag and splatter to provide a smooth surface.
- E. Install valves with stems upright or horizontal, not inverted.
- F. Install valves with clearance for installation of insulation and allowing access.

- G. Provide access where valves and fittings are not accessible.
- H. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.
- I. Valve Applications:
  - 1. Install shutoff and drain valves at locations as indicated on Drawings and as specified in this Section.
  - 2. Install shutoff and isolation valves.
  - 3. Isolate equipment, part of systems, or vertical risers as indicated on Drawings.
  - 4. Install valves for throttling, bypass, or manual flow control services as indicated on Drawings.

### 3.4 FIELD QUALITY CONTROL

- A. Valve Field Testing:
  - 1. Test for proper alignment.
  - 2. If specified by valve Section, field test equipment to demonstrate operation without undue leakage, noise, vibration, or overheating.
  - 3. Engineer will witness field testing.

END OF SECTION

## SECTION 40 05 51.15 - GATE VALVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes gate valves for use in pump stations. Coordinate with Section 40 05 13, Common Work Results for Process Piping.
- B. Section Includes:
  - 1. Resilient-seated gate valves.
- C. Related Sections:
  - 1. Section 40 05 13, Common Work Results for Process Piping
  - 2. Section 40 05 51, Common Requirements Results for Process Valves.

#### 1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers (ASME):
  - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
  - 2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.
  - 3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
  - 4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
- B. ASTM International (ASTM):
  - 1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 3. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- C. American Water Works Association (AWWA):
  - 1. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
  - 2. AWWA C550 - Protecting Interior Coatings for Valves and Hydrants.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
  - 1. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
  - 2. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.

- E. NSF International (NSF):
  - 1. NSF/ANSI Standard 61 - Drinking Water System Components - Health Effects
  - 2. NSF/ANSI Standard 372 - Drinking Water System Components - Lead Content

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. As required by Section 40 05 51, Common Requirements Results for Process Valves.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the “lead free” requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.
  - 1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for “lead free”.
  - 2. All brass in contact with potable water shall comply with ASTM B584.

### 2.2 RESILIENT-SEATED GATE VALVES

- A. Description:
  - 1. Comply with AWWA C509.
  - 2. Minimum Pressure Rating:
    - a. Twelve-inch Diameter and Smaller: 200 pounds per square inch (gauge) (psig).
  - 3. End Connections: As shown in the Drawings.
    - a. Flanged end dimensions and drilling comply with ANSI/ASME B16.1, class 125. Comply with AWWA C115 & ASME 16.5.
      - 1) The Contractor shall coordinate with pipe, valve, and fitting suppliers to make certain pipe, valve, and fitting flanges match in bolt pattern.
  - 4. Gear Actuators: Conforming to AWWA C509 for manual valves.
  - 5. Linings and Coatings:
    - a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.
    - b. All internal and external ferrous surfaces.
    - c. Do not coat flange faces of valves.

6. Bi-directional flow.
- B. Operation:
1. Non-rising stem.
  2. Open counterclockwise when viewing the valve from above, unless otherwise indicated in the Drawings.
  3. In-Plant Service Valves: Valves for in-plant or exposed service shall be furnished with handwheel operators, unless otherwise specified in Section 40 05 51, Common Requirements Results for Process Valves.
- C. Materials:
1. Wedge:
    - a. ASTM A126, cast iron.
    - b. Fully encapsulated with molded rubber.
  2. Body and Bonnet:
    - a. ASTM A126, cast iron or ASTM A536, ductile iron.
  3. Stem, Stem Nuts, Glands, and Bushings: ASTM B584, bronze.
  4. Valve Body Bolting: Stainless steel.
- D. Manufacturers:
1. Mueller Company
  2. American AVK
  3. American Flow Control
  4. Clow Valve Company
  5. No Substitutions.

### 2.3 GENERAL-DUTY GATE VALVES – SMALLER THAN 3 INCHES

- A. Two inches and Smaller:
1. MSS SP 80, Class 125.
  2. Body and Trim: ASTM B584, bronze.
  3. Bonnet: Union.
  4. Operation: Handwheel.
  5. Inside screw .



6. Wedge Disc: Solid; ASTM B584, bronze.
  7. End Connections: Threaded.
- B. Two and one-half inches to 3 inches:
1. MSS SP 70, Class 125.
  2. Stem: Non-rising.
  3. Body: ASTM A126, cast iron.
  4. Trim: Bronze.
  5. Bonnet: Bolted bonnet.
  6. Handwheel, outside screw and yoke.
  7. Wedge Disc: Solid, with bronze seat rings.
  8. End Connections: ASME B16.1, ASME B16.5, ASME B16.42, flanged.

#### 2.4 SOURCE QUALITY CONTROL

- A. Testing: Test gate valves according to AWWA C509.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. As required by Section 40 05 51 - Common Requirements Results for Process Valves.
- B. Install according to Manufacturer's instructions.
- C. Support valves in plastic piping to prevent undue stresses on piping.

END OF SECTION

## SECTION 40 05 51.24 - CHECK VALVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Work in this Section includes check valves for use in water and wastewater facilities. Work includes the furnish and install of all swing and silent check valves, complete, as shown on the Drawings and specified herein, including coating and lining, appurtenances, operators, and accessories.
- B. Section includes:
  - 1. Silent check valves.
- C. Related Sections:
  - 1. Section 40 05 51 - Common Requirements Results for Process Valves

#### 1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers (ASME):
  - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
  - 2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
  - 3. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings.
- B. ASTM International (ASTM):
  - 1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 2. ASTM A536 - Standard Specification for Ductile Iron Castings.
  - 3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
  - 4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.
  - 5. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
  - 6. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
  - 7. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
  - 8. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
- C. American Water Works Association (AWWA):

1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
- D. NSF International (NSF):
1. NSF 61 - Drinking Water System Components - Health Effects.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. As required by Section 40 05 51, Common Requirements Results for Process Valves.

## PART 2 PRODUCTS

### 2.1 SILENT CHECK VALVES

- A. Description:
1. Type: Wafer-style, silent operating type that begins to close as the forward velocity diminishes and be fully closed at zero velocity, preventing flow reversal and resultant water hammer or shock.
  2. Valve design shall incorporate a center-guided, spring-loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe.
  3. Valve Interior: Contoured and unrestricted to achieve maximum flow capacity along with minimum pressure drop.
  4. Installation: Operation of the valve shall not be affected by the position of installation. It shall be capable of operating in the horizontal or vertical position with the flow up or down.
  5. Valve Disc: Concave to the flow direction providing for disc stabilization, maximum strength, and minimal flow velocity to fully open the valve.
  6. All component parts shall be field replaceable without the need of special tools.
  7. A replaceable guide bushing shall be provided and held in position by the valve's spring.
  8. Spring: Designed to withstand 100,000 cycles without failure and exert a force which allows the valve to start opening at a differential pressure of .5 pounds per square inch (psi) (.04 kilograms per square centimeter (kg/cm<sup>2</sup>)) and to fully open at a flow velocity of 4 feet per second (1.22 meters per second).
  9. The valve disc and seat shall be field replaceable and have a seating surface finish of 32 micro-inch or better to insure positive seating at all pressures.
  10. Valve shall be hydrostatically tested at 1.5 times the rated working pressure.
  11. Working Pressure: 150 psi

12. End Connections: ASME B16.1, flanged. End connections shall be rated to the working pressure requirements specified above.

B. Materials:

1. Body: ASTM A536, ductile iron.
2. Trim: Stainless steel.
3. Spring: ASTM A313 Type 316 Stainless steel.
4. Resilient Seat: Buna-N

C. Finishes:

1. Epoxy lining and coating conforming to AWWA C210.

D. Manufacturer:

1. Val-Matic.
2. No other substitutions allowed.

## 2.2 SOURCE QUALITY CONTROL

A. Testing:

1. Hydrostatically test check valves at twice rated pressure, in conformance with requirements of AWWA C508.
2. Permitted Leakage at Indicated Working Pressure: None.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install check valves according to AWWA C508, Section 40 05 51 Common Requirements Results for Process Valve, and as recommended by Manufacturer.

### 3.2 SERVICES PROVIDED BY MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of the Valve Manufacturer's representative to verify proper installation of the valves and to adjust the valves when construction is complete.

END OF SECTION

## SECTION 40 05 67.39 - PRESSURE-RELIEF VALVES

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Spring-loaded pressure-relief valves.

B. Related Sections:

1. Section 40 05 51 – Common Requirements Results for Process Valves.

#### 1.2 REFERENCE STANDARDS

A. ASME International:

1. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

B. ASTM International:

1. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
2. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
3. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

C. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

#### 1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with installation of process tanks.

#### 1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit Manufacturer catalog information.

C. Shop Drawings: Indicate materials, size, and accessories.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures and setting dimensions.

- F. Source Quality-Control Submittals: Indicate results of shop tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of pressure-relief valves.

#### 1.6 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- C. Store materials according to Manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
  - 3. Provide additional protection according to Manufacturer instructions.

#### 1.8 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

#### 1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

### PART 2 PRODUCTS

#### 2.1 PRESSURE-RELIEF VALVES, SPRING LOADED

- A. Description:
  - 1. Size: 3inches.

2. Style: Globe
3. Configuration: Vent to atmosphere
4. Performance and Design Criteria:
  - a. Flow Capacity: 100 gpm at 110 psig pressure setting.
  - b. High Pressure Pilot Range: 0-200 psig.
  - c. Low Pressure Pilot Range: 2-30 psig
5. Materials:
  - a. Body: Ductile Iron
  - b. Trim: Type 316 stainless steel
  - c. Disc: Buna-N
6. End Connection: Flanged, ASME B16.5.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.
- C. Certificate of Compliance:
  1. If Manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at Manufacturer's facility conforms to Contract Documents.
  2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that field dimensions are as indicated on Drawings.

### 3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Thoroughly clean end connections before installation.
- C. Cleaning: Clean surfaces to remove foreign substances.

### 3.3 INSTALLATION

- A. According to Manufacturer instructions and local code requirements.
- B. Repair damaged coatings with material equal to original coating.

### 3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

### 3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Keep interior of valves clean as installation progresses.

### 3.6 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION



## SECTION 40 05 78 - MISCELLANEOUS VALVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes miscellaneous valves not included in other Sections for use in pump stations.
- B. Section Includes:
  - 1. Strainer.
  - 2. Air release valves.
  - 3. Ball valves, 2 inches and under.
- C. Related Sections:
  - 1. Section 40 05 13, Common Work Results for Process Piping.
  - 2. Section 40 05 51, Common Requirements Results for Process Valves.

#### 1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers (ASME):
  - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
  - 2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard.
  - 3. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
  - 4. ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
  - 5. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
- B. ASTM International (ASTM):
  - 1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - 2. ASTM A536 - Standard Specification for Ductile Iron Castings.
  - 3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

#### 1.3 COORDINATION

- A. Contractor shall be solely responsible to coordinate Work of this Section with piping, equipment, and appurtenances.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit Manufacturer's latest published literature. Include illustrations, installation and maintenance instructions, and parts lists.
  - 2. Submit valve cavitation limits.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions: Submit installation instructions and special requirements, including storage and handling procedures.
- E. Lining and coating data.
- F. Valve Labeling Schedule: Indicate valve locations and nametag text.
- G. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves and actuators.
- B. Operation and Maintenance Data: Submit information for valves.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts:
  - 1. Furnish one set of Manufacturer's recommended spare parts.
- B. Tools:
  - 1. Furnish special wrenches and other devices required for Owner to maintain equipment.
  - 2. Furnish compatible and appropriately labeled toolbox when requested by Owner.

#### 1.7 QUALITY ASSURANCE

- A. Cast Manufacturer's name, pressure rating, size of valve, and year of fabrication into valve body.
- B. Valve Testing: Each valve body shall be tested under a test pressure equal to twice its design water-working pressure.
- C. Maintain clearances as indicated on Drawings.

- D. Unless otherwise noted, all water works materials provided for the Project shall be new, of first-class quality and shall be made by reputable manufacturers.
- E. All material of a like kind shall be provided from a single manufacturer, unless otherwise approved by the Engineer.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- B. Store materials according to Manufacturer instructions.
  - 1. Store materials in areas protected from weather, moisture, or other potential damage.
  - 2. Do not store materials directly on ground.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
  - 3. Provide additional protection according to Manufacturer instructions.
- D. Handle products carefully to prevent damage to interior or exterior surfaces.
- E. All defective or damaged materials shall be replaced with new materials at no cost to the Owner.

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. All materials in contact with potable water shall conform to ANSI/NSF Standard 61 and meet the "lead free" requirements of the Safe Drinking Water Act amendment, effective January 4, 2014, as per the lead content evaluation procedures outlined in NSF/ANSI Standard 372.1.
  - 1. All fittings shall either be cast or permanently stamped with markings identifying the item as complying with NSF 61 per the requirements of NSF 372 for "lead free".
  - 2. All brass in contact with potable water shall comply with ASTM B584.

#### 2.2 STRAINER

- A. Description:
  - 1. Type: H-Strainer.
  - 2. Cover Seal: Buna-N Synthetic Rubber

3. Strainer: 316 Stainless Steel
  4. Strainer Mesh Size: 10 Mesh
  5. Drain/ Blow-off:
    - a. Size: 1 ¼ inch diameter
    - b. Connection: NPT
  6. End Connections: ASME B16.1, ASME B16.5, ASME B16.42, flanged.
- B. Manufacturers:
1. Val-Matic, or approved equal
- C. Materials:
1. Body: ASTM A536, ductile iron.
  2. Linings and Coatings:
    - a. Corrosion-resistant fusion bonded epoxy conforming to AWWA C550 and NSF 61.
    - b. All internal and external ferrous surfaces.
    - c. Do not coat flange faces of valves.

## 2.3 AIR RELEASE VALVES

- A. Description:
1. Inlet Size: 2-inch diameter and smaller.
  2. Cast-iron body and cover. Comply with ASTM A126, Class B.
  3. Stainless steel orifice and float. Comply with ASTM A240.
  4. Design test pressure: 450 psig.
- B. Manufacturers:
1. DeZurik - APCO Series 200A or equal.

## 2.4 BALL VALVES, 2 INCHES AND UNDER

- A. Description:
1. Four hundred-pound. Water, oil, and gas rating (WOG) with bronze body and trim, unless otherwise shown on the Drawings.
  2. Seat ring: Tetrafluoroethylene (TFE).
  3. O-ring seals: Fluorocarbon.

4. Three-piece construction so that maintenance can be performed without distributing the valve body after installation.
- B. Manufacturer:
1. Nibco T-590-Y or equal.

## 2.5 SOURCE QUALITY CONTROL

- A. Testing Pressure-Reducing and Pressure-Sustaining Valves:
1. Leakage Testing:
    - a. Test each assembled valve hydrostatically at 1-1/2 times rated working pressure for minimum five minutes.
    - b. Test each valve for leakage at rated working pressure against closed valve.
    - c. Permitted Leakage: None.
  2. Functional Testing:
    - a. Test each valve to verify specified performance.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install valves per Manufacturer requirements and recommendations.
- B. Install all valves with valve seats level.

END OF SECTION

## SECTION 40 71 13 - MAGNETIC FLOW METERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Magnetic flow meters.
  - 2. Transmitters.
  - 3. Indicators.
  - 4. Recorders.
  - 5. Integrators.
- B. Related Sections:
  - 1. Section 26 00 00 - Basic Electrical Materials and Methods

#### 1.2 REFERENCE STANDARDS

- A. American Water Works Association:
  - 1. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
  - 2. AWWA M33 - Flowmeters in Water Supply.
- B. ASME International:
  - 1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. NSF International:
  - 1. NSF 61 - Drinking Water System Components - Health Effects.
  - 2. NSF 372 - Drinking Water System Components - Lead Content.

#### 1.3 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate Work of this Section with piping work.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit Manufacturer information for system materials and component equipment, including connection requirements.
- C. Shop Drawings:

1. Indicate system materials and component equipment.
  2. Submit installation requirements and other details.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Manufacturer Reports: Certify that equipment has been installed according to Manufacturer instructions.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

#### 1.6 QUALITY ASSURANCE

- A. Ensure that materials of construction of wetted parts are compatible with process liquid.
- B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.
- C. Perform Work according to City of Thornton and Colorado Department of Health and Environment standards.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- C. Store equipment according to Manufacturer instructions.
- D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  2. Provide additional protection according to Manufacturer instructions.

#### 1.8 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

## PART 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Furnish sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, interconnecting cables, and unit conversions and algorithms as required for application.

### 2.2 MAGNETIC FLOW METERS

- A. Manufacturers:
  - 1. Badger
  - 2. Substitutions: Not permitted.
- B. Description: Low-frequency, electromagnetic induction-type flow meter, producing a linear signal directly proportional to flow rate, consisting of flow tube, signal cable, and transmitter.
- C. Performance and Design Criteria:
  - 1. Design: According to AWWA M33.
- D. Flow Rate Range: 0.01 to 500 gpm.
- E. Size: As indicated on Drawings.
- F. Flow Tubes:
  - 1. Material: Type 304 stainless steel.
  - 2. End Connections: Flanged, ASME B16.1, carbon steel.
- G. Electrodes:
  - 1. Type 316L stainless steel.
  - 2. Self-cleaning.
- H. Accuracy: Plus or minus 1 percent of actual flow rate over a 10:1 range.
- I. Provide adjustment for zero and span.
- J. Accessories:
  - 1. Furnish cable between transmitter and receiver.

### 2.3 TRANSMITTERS

- A. The transmitter shall be microprocessor based, and shall energize the sensor coils with a digitally controlled pulsed DC. The excitation frequency shall be program selectable for the following: 1Hz, 3.75Hz, 7.5Hz, or 15Hz. (factory optimized to pipe size and application)



- B. The transmitter electrical power requirement shall be 85-265VAC, 45-65Hz. The power consumption shall not exceed 15W.
- C. The transmitter shall have an ambient temperature rating of -4°F to 140°F [-20°C to 60°C].
- D. The transmitter shall include non-volatile memory capable of storing all programmable data and accumulated totalizer values in the event of a power interruption.
- E. Automatic zero stability, low flow cut-off, empty pipe detection and bi-directional flow measurement shall be inherent capabilities of the transmitter.
- F. All transmitter outputs shall be galvanically isolated to 250 volts.
- G. The transmitter and remote junction enclosures shall be constructed of cast aluminum (powder-coated paint) and shall meet NEMA 4X/6P (IP66/IP67) ratings.
- H. The transmitter shall provide a total of four digital outputs, one analog output and one digital input
  - 1. Up to four open collector digital outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, reset output, error alarm and 24V supply.
  - 2. Up to two active digital (24 Volt) outputs, program selectable from the following: Forward pulse, reverse pulse, AMR pulse, flow set point, empty pipe alarm, flow direction, preset output, error alarm and 24V supply.
  - 3. Up to two AC solid-state relay outputs, program selectable from the following: Frequency output, flow set point, empty pipe alarm, flow direction, preset amount and error alarm.
  - 4. One digital input, program selectable from the following: Remote reset, batch reset and positive return to zero.
  - 5. Advanced protocol support using Modbus/RTU.
  - 6. One analog output programmable and scalable from the following: 0-10mA, 0-20mA, 2-10mA or 4-20mA. Voltage sourced and isolated. Max. loop resistance = 800 ohms.
  - 7. Advanced protocol support communication thru AquaCUE

Advanced protocol support communication thru BACnet MS/TP
- I. HMI:
  - 1. Touch-screen programming, functioning through enclosure window without opening enclosure.
  - 2. Display:
    - a. Size: Four lines by 20 characters.
    - b. Type: Backlit digital display.

- c. User-selectable engineering units.
- d. Readout of diagnostic error messages.

## 2.4 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of meters according to AWWA M6.
- C. Owner Inspection:
  - 1. Notify Owner at least seven days before inspection is allowed.
- D. Certificate of Compliance:
  - 1. If Manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at Manufacturer's facility conforms to Contract Documents.
  - 2. Specified shop tests are not required for Work performed by approved manufacturer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

### 3.2 INSTALLATION

- A. Coordinate location and orientation of flow meter with final equipment installations.
- B. Ensure that instruments are located to be easily accessible for maintenance.
- C. Follow manufacturer's recommendation for installation. Installation will conform to the guidelines provided by the Installation & Operation Manual.
- D. Straight pipe requirement shall be an equivalent of three diameters on the inlet (upstream) side, and two diameters on the outlet (downstream) side

### 3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Testing:
  - 1. Test and calibrate flow meter to demonstrate that it meets specified accuracy requirements.
  - 2. Comply with AWWA M6.

- C. Manufacturer Services: Furnish services of Manufacturer's representative experienced in installation of products furnished under this Section for not less than seven days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- D. Equipment Acceptance:
  - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
  - 2. Make final adjustments to equipment under direction of Manufacturer's representative.
- E. Furnish installation certificate from Equipment Manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

#### 3.4 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

## SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Pressure gauges.
- B. Related Sections:
  - 1. Section 43 05 20 - Common Work Results for Liquid Handling Equipment.

#### 1.2 REFERENCE STANDARDS

- A. ASME International:
  - 1. ASME B40.100 - Pressure Gauges and Gauge Attachments.
- B. NSF International:
  - 1. NSF 61 - Drinking Water System Components - Health Effects.
  - 2. NSF 372 - Drinking Water System Components - Lead Content.

#### 1.3 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate Work of this Section with Piping Work.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit Manufacturer information for system materials and component equipment, including connection requirements.
- C. Shop Drawings:
  - 1. Indicate system materials and component equipment.
  - 2. Submit installation requirements and other details.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of equipment and accessories.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Extra Stock Materials:
  - 1. Gauges Other Than Diaphragm Protected: Furnish 20 percent spare gauges, with a minimum of one gauge for each range used.
  - 2. Diaphragm-Protected Gauges: Furnish 20 percent spare gauges, with a minimum of one gauge for each range used, complete with diaphragm seals.

## 1.7 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- C. Store materials according to Manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to Manufacturer instructions.

## 1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

## PART 2 PRODUCTS

### 2.1 PRESSURE GAUGES

- A. Design Information:
  - 1. Nominal Diameter: 4 inches (114 mm).
  - 2. Face: White, laminated plastic dials with black graduations.
  - 3. Scale: Extend over arc not less than 270 degrees.

4. Ranges and Graduation Units: 0 to 250 psig.
- B. Cases:
1. Liquid filled.
  2. Material: Phenolic or high-impact polypropylene.
  3. Type: Blowout protected.
  4. Blowout Disc Encasement Material: Phenolic.
  5. Provide removable rear plate.
  6. Windows:
    - a. Material: Clear, shatterproof glass.
    - b. Thickness: 1/8 inch.
    - c. Provide gasket.
- C. Connection:
1. Location: Bottom.
  2. Socket:
    - a. 1/4-inch NPT male thread.
    - b. Material: Brass forging.
    - c. Extend minimum 1-1/4 inches below gauge cases.
    - d. Provide wrench flats.
  3. Mounting: Stem
- D. Measuring Element:
1. Bourdon Tubes:
    - a. Material: Phosphor bronze, Stainless steel, silver-soldered, or brazed to brass socket.
    - b. Provide welded, stress-relieved joints.
  2. Movement:
    - a. Rotary geared.
    - b. Material: Stainless steel.
  3. Accuracy:
    - a. Comply with ASME B40.100.

- b. Plus and minus 2percent of full-scale range.
- E. Adjustment:
  - 1. Provide for zero-reading adjustment.
  - 2. Adjusting Screws: Accessible from rear of case without need for disassembly.
- F. Accessories:
  - 1. Pressure Snubber:
    - a. Material: Type 316 stainless steel.
    - b. Provide isolation valve.
  - 2. Shutoff Cocks: Furnished by Gauge Manufacturer.

## 2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Provide shop inspection and testing of completed assembly.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

### 3.2 INSTALLATION

- A. According to Manufacturer instructions.
- B. Coordinate location and orientation of gauges and seal assemblies with final piping and equipment installations.
- C. Ensure that gauges are located to be easily read during operation and easily accessible for maintenance.
- D. Installation Standards: Install Work according to <\_\_\_\_\_> standards.

### 3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of Manufacturer's representative.

3.4 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION



## SECTION 40 90 00

### INSTRUMENTATION AND CONTROLS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. This section covers the furnishing and installation of metering and control equipment which shall include the following principal items:
  - 1. Metering and Control Systems. Principal components of the metering and control systems shall be as listed on the “Instrument List” at the end of this section and shall include the PLC system as is shown on the Drawings.
  - 2. Miscellaneous. One lot of test equipment, spare parts, and miscellaneous devices as set forth herein. Supplementing this section, the drawings indicate locations and arrangement of panels and instruments, and provide functional diagrams and schematics regarding connection and interaction with other equipment.
  
- B. Related Sections
  - 1. Division 01 – Materials and Equipment
  - 2. Section 26 00 00 – Electrical
  - 3. Section 26 29 23 – Variable Frequency Drives

##### 1.2 REFERENCES

- A. Codes & Permits
  - 1. All work and materials shall comply with the National Electrical Code, the National Electrical Safety Code, and applicable local regulations and ordinances. All panels shall be listed by Underwriters Laboratories or other testing organizations acceptable to the governing authority. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

##### 1.3 SUBMITTALS

- A. Complete fabrication, assembly, and installation drawings: wiring and schematic diagrams: and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in two separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Instrument tag numbers indicated on the contract drawings shall be referenced where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.
  - 1. First-stage Submittal. The first-stage submittal shall include the following items.
    - a. Product catalog cut sheets clearly marked to show the applicable model number, operational features, and intended service of the device.

- b. A detailed list of any exceptions, functional differences, or discrepancies between the Supplier's proposed system and the contract requirements.
  - c. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.
  - d. System wiring and installation drawings for all interconnecting wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.
  - e. If panel terminal designations, interdevice connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.
  - f. A total of seven (7) copies for the submittal shall be provided.
2. Second-stage Submittal. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.
- a. Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings, calibration and startup sheets shall be included with the manuals.
  - b. A copy of all final O&M manuals shall be provided in PDF format on a USB Thumb drive. All AutoCAD drawings shall be provided in PDF and DWG formats.
  - c. A total of two (2) printed copies, and two (2) softcopies of final O&M manuals shall be provided.

#### 1.4 QUALITY ASSURANCE

##### A. Supplier's qualifications

- 1. The entire system shall be designed, coordinated, and supplied by a qualified system integrator (Integrator) who is regularly engaged in the business of designing and building instrument and control systems for water and wastewater projects. The Contractor's intended Integrator shall meet the following qualifications.
  - a. The Integrator shall have and shall maintain a qualified technical staff and design office. The qualifications and experience of key project personnel shall be acceptable to the Engineer.
  - b. The Integrator shall have the physical plant and fabricating personnel to complete the work specified. The Integrator's fabrication capabilities and arrangements shall be acceptable to the Engineer.
  - c. The Integrator shall employ competent service personnel to service the equipment furnished. The geographic location of service personnel for this project shall be acceptable to the Engineer.
  - d. The Integrator shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination.

1. Instrument and control systems shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All instruments and control devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufactured and the manufacturer of related equipment.
2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
3. The Integrator shall provide coordination with other contractors and supervision of installation as required during construction.
4. Coordination shall be provided between the Integrator and the process system supplier.
5. Instrument and control systems shall be designed and coordinated for proper operation with other sections of these specifications. These shall include but not be limited to Materials and Equipment – Division 01, Electrical – Section 26 00 00, Variable Frequency Drives – Section 26 29 23, and Programmable Logic Controllers – Section 40 95 00.

1.5 WARRANTY

- A. All suppliers shall warrant their hardware for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
1. Power and Instrument Signals. Unless specified otherwise, electrical power supply to the instrumentation equipment will be unregulated 120 VAC at the locations noted on the one-line and functional diagrams. All transmitted electronic analog instrument signals shall be 4-20 mA DC and shall be linear with the measured variable.
  2. Metering Accuracy. System metering accuracy, as compared to the actual process value, shall be determined from the value read at the principal readout device such as the recorder or totalizer. System requirements shall not preclude any requirements specified herein for individual devices.
    - a. For systems where the primary measuring device, transmitter, and receiver are furnished under this section, the accuracies shall be within the following limits:
      - i) Level: 1.0% of measured span.

- ii) Flow Rate: magnetic or transit time ultrasonic metering: 0.5% of full scale between 1.0 and 100% of scale.
- 3. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation requirements shall be furnished and installed as required for proper performance of the equipment.
- 4. Interchangeability and Appearance. Instruments used for the same types of functions and services shall be of the same brand and model line insofar as possible. Similar components of different instruments shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished. Recorders, process indicators, control stations, and similar panel-mounted instruments shall be of the same style and shall be products of the same major instrument manufacturer.
- 5. Programming Devices. A programming or system configuring device shall be provided for systems that contain any equipment which required such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete and in like-new condition and shall be turned over to the Owner at completion of the startup.
- 6. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanels, and rack-mounted devices shall have laminated plastic identification tags securely fastened to the device. Hand lettered labels or tape labels will not be acceptable.
- 7. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
- 8. Provide sunshade for outdoor installations.
- 9. Provide stainless steel tags for each instrument.

## 2.2 PANEL FABRICATION

- A. General Fabrication Requirements. All panels furnished hereunder shall conform to the requirements of NEMA ICS-6-1988. The following paragraphs describe general fabrication requirements for the instrument panels, consoles, enclosures, and subpanels:
  - 1. Wiring.
    - a. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded tinned copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90°C.
    - b. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 VAC. Surge protectors shall be of a non-faulting and non-interrupting design, with a response time of not more than 5 nanoseconds. Surge protectors shall be Cutler Hammer AEGIS Powerline Filters, or equal.
    - c. Panels that are over 15 cubic feet in total volume shall have panel lighting above each door of the panel.

- d. Power distribution wiring on the line side of the panel's protective devices shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 16 AWG. Wiring for control circuits shall be minimum 16 AWG. Electronic analog circuits shall be 18 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color coding legend on the system supplier's panel wiring diagrams.
  - e. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with a marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 20% spare terminals shall be provided. Each control loop or system shall be individually fused, and all fused or circuit breakers shall be clearly labeled and located for easy maintenance. Terminal block shall be Phoenix Contact UT 4-MTD series.
  - f. All wiring shall be grouped and firmly supported inside the panel. Wiring shall be routed in nonmetallic slotted wire duct or similar. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40% of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables. Wire duct shall be Thomas & Betts Ty Duct or approved equal.
  - g. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams.
  - h. All analog input signals coming from external from the building where the panel is located shall have surge protection.
  - i. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.
  - j. All wires in the panel shall be identified at both ends of the wire. These labels shall agree with the labels shown on the wiring diagrams. The wire labels shall be of the heat-shrink tube type of wire marker as manufactured by Brady thermal labels.
  - k. All instruments that require 120vac power that have the signal from the instrument going to a panel, shall be provided 120vac from that panel. The 120vac circuit to these instruments shall be individually fused.
- 2. Uninterruptable Power Supply (UPS)
    - a. Any panels that have PLCs or are shown to have a UPS on the drawings shall have a UPS
    - b. The PLC and all associated equipment shall be powered by a UPS.
    - c. The UPS shall be sized to provide power to all devices connected to it for a minimum of 30 minutes.
  - 3. The UPS shall be wired so that in the event of the UPS failure, the PLC panel will be powered by utility power and an alarm will be generated.
  - 4. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions

and legends, as indicated on the drawings, letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified herein under the Device Tag Numbering System paragraph.

5. Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils.
6. Factory test. Panels shall be factory tested electrically by the panel fabricator before shipment.

## 2.3 METERING & CONTROL SYSTEMS

- A. Principal components for the metering and control systems are indicted on the "Instrument List" at the end of this specification.

## 2.4 CONTROL COMPONENTS

### A. Panel Front-Mounted Devices

1. SELECTOR SWITCHES. Selector switches shall be a minimum 30 mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.
2. INDICATING LIGHTS. Indicating lights shall be a minimum 30 mm, heavy-duty, oil-tight type, Push-to-Test, which uses a low voltage lamp. A built-in transformer shall be used for AC service. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.
3. PUSH BUTTONS. Push buttons shall be a minimum 30 mm, heavy-duty, oil-tight type. Legends shall be engraved on push button faceplate. Contacts shall be rated 10 amperes continuous at 120 VAC. Push buttons shall be Eaton "Series 10250T", Square D "Class 9001", or approved equal.

### B. Panel Interior-Mounted Devices

1. POWER SUPPLIES. Regulated DC power supplies for instrument loops shall be provided as needed. Power supplies shall be suitable for input voltage variation of plus or minus 10%. The DC power supplies shall be Idec "PS5R Slim line", or Phoenix Contact "UNO".
2. RELAYS. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL listed. Relays shall have

a minimum rating of 10 amperes at 120 VAC. Time-delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of +/- 2.0% of setting. Latching and special purpose relays shall be as required for the specific application. Relays shall have a light to indicate when coil is energized. Relays shall be Idec "RH or RTE Series" or approved equal.

## 2.5 INSTRUMENTATION

### A. Flow Instrumentation

#### 1. Magnetic Flow Meters

- a. The Magnetic Flow Meter shall be a completely obstruction less, in-line flow meter with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5, Class 150 for 24" and smaller, and AWWA Class D for 28" and larger. Meters shall be suitable for the maximum range of working pressures of the adjacent piping. Electrode and liner materials shall be fully compatible with the process fluid and shall comply with the requirements specified in the instrument device schedules. Each meter shall be factory calibrated, and a copy of the calibration report shall be submitted as part of the operation and maintenance manual submittal.
- b. In vaults, wet wells and all other below grade locations the flow meter shall be IP68/NEMA 6P Protection.
- c. The meter shall be capable of standing empty for extended periods of time without damage to any components. The meter housing shall be of a splash-proof and drip-proof design.
- d. Power supply to the meter shall be 120 VAC, 60 Hz, single phase.
- e. Provide NSF61 Drinking Water approval for Water Applications.
- f. Meters shall be Rosemount Type 8750W, or approved equal.

### B. Pressure and Level Instrumentation

#### 1. Gauge Pressure and Pressure Sensing Level Transmitters.

- a. Transmitters used to measure process pressure or inferred level from process pressure such as a bubbler system or other source, shall include diaphragm type piezo resistive pressure transducer and microprocessor-based electronics. Transmitters shall be 24VDC loop power. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping.
- b. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0 to 180°F. All transmitter parts shall be of a corrosion-resistant material.
- c. Vents shall be provided on the sides of the diaphragm housing body. Transmitter shall have over-range protection to 1.5 times the upper range limit.
- d. Accuracy shall be plus or minus 0.5% of calibrated span, with repeatability of 0.1%.
- e. Transmitter output shall be 4-20mA DC without the need for external load adjustments and shall have an elevated or suppressed zero as required by the application.

- f. Display shall be integrally mounted 2-Line LCD display scaled with engineering units.
  - g. Each transmitter shall be provided with a process shutoff valve and a bracket for mounting as required.  
OPTIONAL: Bluetooth Enabled
  - h. Transmitters shall be Rosemount “Model 2088”, or, approved equal.
2. Hydrostatic Level Transducers
- a. Each transducer shall be a hydrostatic pressure sensor for submerged level measurement of fresh water and wastewater applications. The sensor shall be a permanently sealed submersible probe and cable combination with waterproof 316 Stainless Steel Housing. The transducer shall be a of the two-wire type which requires no direct power connection to the transducer. Transducer output shall be 4-20mA DC. The transducer shall be capable of the ranges and pressures for which the application will require. The transducer shall have an operating temperature range of 0 to 140°F. Accuracy shall be +/- 0.35%. Transducer should be protected from moisture intrusion with a vent filter. The transducer shall be mounted as shown on drawings or as required for application. The transducer shall be an Endress-Hausser “Waterpilot FMX21”, GE Sensing (Druck) “PDCR/PTX- 1730”, Mercoid SBLT2, or approved equal.
3. Conductance Relay Level Switch
- a. Each level switch shall consist of a single-pole, double-throw relay with contacts rated not less than 5 amperes ac at 120 VAC. The relay primary power shall be 120 VAC. The electrodes shall be flexible wire suspension type with shielded stainless steel electrode tips. The electrode holder shall be the manufacturer’s standard holder appropriate for the application.
  - b. Electrodes and conductance relay shall be as manufactured by Gems Sensors (Warrick Controls) or Ametek (BW Controls), or approved equal.
- C. Miscellaneous Instrumentation
1. Limit Switch
- a. The limit switch shall be of the lever operated limit switch type and shall be enclosed in a NEMA 4 housing. The switch shall be furnished with one NO and one NC contacts and screw type wiring terminal. The switch shall be heavy duty, oil tight type. Limit switches shall be Square D model “9007C54B2” with adjustable type roller lever arm “9007HA1” or approved equal.
2. Magnetic Door Switch
- a. The magnetic door switch shall be a two-piece switch rated 100V AC/DC. Switch shall be Edwards 60 Series or approved equal.
3. Temperature Switch
- a. Temperature switches shall be constructed with an all-metal case. Switches shall have contacts rated 10A at 120 VAC.
  - b. Switches shall be Dayton Model 1UHH1 or approved equal.



## PART 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

#### A. General Requirements

1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system Supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

#### B. Inspection.

1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
  - a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

#### C. Equipment Installation.

1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
  - a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
  - b. Perform all work in accordance with manufacturer's instructions.
    - i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
    - ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
  - c. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.
  - d. Field Piping. Field piping materials and installation shall conform to the requirements of the miscellaneous piping section.
  - e. Field-Mounted Instruments. Instruments shall be mounted so they may be easily read and serviced and all appurtenant devices are easily operated. Installation details for some instruments are indicated on the drawings. Unless otherwise indicated on the drawings, instruments which include local indicators shall be mounted approximately 5 feet above the floor and shall be oriented for ease of viewing. Transmitters shall be mounted on corrosion-resistant pipe supports suitable for floor, wall, or bracket mounting.

- #### D. Field Calibration.
- A technical representative of the system supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final tuning adjustment settings. The adjustment of each calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instruments shall be calibrated before checkout of the operation of the system.

- #### E. Systems Check.
- A technical representative of the system supplier shall participate in the checkout of metering and control systems. If interrelated devices furnished by other

suppliers, such as valve actuators, motor controls, chemical feeders, or primary measuring devices, do not perform properly when placed in service, the technical representative shall use suitable test equipment to introduce simulated signals to verify or measure signals from such devices as required to locate the source of trouble or malfunction. A written report stating the results of such tests shall be furnished, if requested by the Engineer, to assign responsibility for corrective measures.

1. Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by the Contractor for the duration of the testing work. Unless specified otherwise, test equipment will remain the property of the Contractor or the system Supplier.

F. Adjustment and Cleaning

1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

3.2 CUSTOMER TRAINING

- A. The coordinating supplier shall provide a qualified representative at the job site to train the Owner’s personnel in operating and maintenance of the equipment. The training session shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of one 4-hour session, and the schedule shall be arranged and coordinated with the Engineer.

3.3 INSTRUMENT LIST

Grange Creek Pump Station  
Instrument List

(This list does not include instruments provided by the packaged systems)

<u>Tag #</u>	<u>Description</u>	<u>Service</u>	<u>Scale</u>	<u>Provided Under Specification</u>
ZS-1	Building Intrusion	Magnetic Door Switch		40 90 00
TSL-1	Building Low Temperature	Temperature Switch		40 90 00
WOF-1	Building Water on Floor	Conductance Relay Level Switch		40 90 00
ZS-100	Hatch Intrusion	Limit Switch		40 90 00
FIT-100	Well Flow	Magnet Flow Meter	4-20MA	40 90 00
LIT-150	Wetwell Level	Hydrostatic Level Transducer	4-20MA	40 90 00
FIT-200	Discharge Flow	Magnetic Flow Meter	4-20MA	40 90 00
PIT-200	Station Discharge Pressure	Guage Pressure	4-20MA	40 90 00

END OF SECTION

## SECTION 40 95 00

### PROGRAMMABLE LOGIC CONTROLLERS

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. This section includes the items listed below and all other components necessary for a complete system as noted herein and indicated on the drawings
  - 1. Programmable Logic Controllers (PLCs)
  - 2. Communication equipment
  - 3. HMI software
  - 4. Programming
  - 5. Spare parts
  
- B. Related Sections
  - 1. Division 01 – Materials and Equipment
  - 2. Section 26 00 00 – Electrical
  - 3. Section 26 29 23 – Variable Frequency Drives
  - 4. Section 40 90 00 – Instrumentation & Controls
  - 5. I/O list

##### 1.2 REFERENCES

- A. ISA 5.1 – Instrumentation Symbols and Identification
- B. NEMA ICS 1 – General Requirements for Industrial Control and Systems
- C. NEMA ICS 2 – Standards for Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600 Volts
- D. DEMA ICS 3 – Industrial Control and Systems: Factory Built Assemblies
- E. NEMA ICS 6 – Industrial Controls and Systems: Enclosures

##### 1.3 DESIGN REQUIREMENTS

- A. Discrete input/output signals shall all be 24VDC
- B. Analog input/output signals shall all be 4-20mA
- C. Analog signal isolators shall be independently powered units capable of driving two 4-20mA signals
- D. All required buffers, isolators, signal converter, and amplifiers for coordination with other equipment furnished under other sections, and between items of equipment needed

for a complete system shall be furnished under this section of the specifications whether indicated on the Drawings or not or detailed in these specifications or not

#### 1.4 SYSTEM DESCRIPTION

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
  - 1. I/O List. An I/O list is attached at the end of this section

#### 1.5 SUBMITTALS

- A. Submittals shall be required as noted in Section 40 90 00.

#### 1.6 QUALITY ASSURANCE

- A. Supplier's qualifications
  - 1. The entire system shall be designed, coordinated, and supplied by the system integrator supplier.
- B. Coordination
  - 1. The PLCs and PLC system shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
  - 2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
  - 3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.

#### 1.7 WARRANTY

- A. The Supplier shall warrant the hardware, software, and configuration related to the operational performance of the facility for a period of two years from the date of system acceptance. The Supplier shall provide a two-year software service agreement to include any and all minor and/or major releases and upgrades, and shall correct any problems or "bugs" which prohibit the SCADA system from performing process operations in accordance with these specifications.

### PART 2 PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

- A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
1. Interchangeability. All PLC systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules shall be interchangeable among all I/O panels and systems.
  2. Installed I/O requirements. Each PLC shall have I/O modules installed to accommodate requirements shown on drawings and the I/O List at the end of this section and with a minimum of 20% spares installed.
  3. Acceptable Manufacturers.
    - a. PLC –Schneider Electric Modicon M340, and no equal.
  4. Modules shall be added as needed to provide for all the I/O required on the project plus the spares.

All Analog signals shall be logged in the Historian Software

## 2.2 MATERIALS AND EQUIPMENT

- A. Programmable Logic Controller (PLC)
1. The additions to the PLC system shall include, but are not limited to, the following components:
    - a. PLC Processor
      - i) BMXP342020
    - b. PLC Power Supply
      - i) BMXCPS3500
    - c. Input/Output Modules
      - i) Digital Input Modules
        - a) Number of Inputs: 18
        - b) Voltage Category: 120VAC
        - c) Module shall be Schneider Electric: BMXDAI1604.
      - ii) Digital Output Modules
        - a) Number of Outputs: 3
        - b) Voltage Category: 120VAC
        - c) Module shall be Schneider Electric: BMXDRA1605
      - iii) Analog Input Modules
        - a) Number of Inputs: 6
        - b) Signal Range: 4-20mA
        - c) Module shall be Schneider Electric: BMXAMI0810
      - iv) Analog Output Modules
        - a) Number of Inputs: 2
        - b) Signal Range: 4-20mA
        - c) Module shall be Schneider Electric: BMXAMO0410

B. Remote Access Equipment

1. Radio
  - a. MDS SD04-MDASSCCSNN – No Equal
- C. Networking Switch
  1. 4 port unmanaged - Phoenix Contact or approved equal.

## PART 3 EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

- A. General Requirements
  1. It shall be the Supplier's responsibility to ensure that the entire PLC system and HMI system is installed in a satisfactory condition per these specifications and the manufacturer's requirements.
- B. Inspection
  1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
    - a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.
- C. Equipment Installation
  1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
    - a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
    - b. Perform all work in accordance with manufacturer's instructions.
      - i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
      - ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
- D. Adjustment and Cleaning
  1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
  2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.
- E. PLC and OIT Programming.
  1. The Contractor shall be responsible for all PLC and OIT programming.

### 3.2 CUSTOMER TRAINING

1. The system supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of the equipment. The training sessions shall include a technical explanation of the equipment and an actual hands-

on demonstration. The training session shall consist of two consecutive 4-hour working days, and the schedule shall be arranged and coordinated with the Engineer.

3.3

GRANGE PARK IPS

I/O List

(Only I/O points other than the packaged systems are shown here)

<u>Tag #</u>	<u>Description</u>	<u>DI</u>	<u>DO</u>	<u>AI</u>	<u>AO</u>	<u>Scale</u>	<u>Notes</u>
PF	PLC Utility Power Fail	1					
RUPS	PLC UPS Power Fail	1					
ZS-1	Building Intrusion	1					
TSL-1	Building Low Temp	1					
WOF-1	Building Water on Floor Alarm	1					
ZS-100	Hatch Intrusion	1					
ZS-110	Irrigation System Call for Water	1					24VAC Interposing relay required.
M-100	Well Pump Running	1					
HS-100	Well Pump In Auto	1					
MA-100	Well Pump Fault	1					
HC-100	Well Pump Run Command		1				
M-150	Pump #1 Running	1					
HS-150	Pump #1 In Auto	1					
MA-150	Pump #1 Fault	1					
HC-150	Pump #1 Run Command		1				
SI-150	Pump #1 Speed Indication			1			
SC-150	Pump #1 Speed Command				1		
M-151	Pump #2 Running	1					
HS-151	Pump #2 In Auto	1					
MA-151	Pump #2 Fault	1					
HC-151	Pump #2 Run Command		1				
SI-151	Pump #2 Speed Indication			1			
SC-151	Pump #2 Speed Command				1		
FP-100	Well Flow Pulse	1					

FIT-100	Well Flow Meter			1			
FP-200	Discharge Flow Pulse	1					
FIT-200	Discharge Flow Meter			1			
LIT-100	Wet Well Level			1			
PIT-200	Station Discharge Pressure			1			
		18	3	6	2		

END OF SECTION



## SECTION 43 05 20 - COMMON WORK RESULTS FOR LIQUID HANDLING EQUIPMENT

### PART 1 GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Lubrication.
2. Pump piping, fittings, and valves.
3. Piping connections.
4. Shaft coupling guards.
5. Accessories.

##### B. Related Sections:

1. Section 03 30 00 - Cast-in-Place Concrete: Equipment support (housekeeping) pads.
2. Section 26 29 23 - Variable-Frequency Motor Controllers: Three-phase variable-frequency motor controllers of pulse-width-modulated design for variable-speed drives.
3. Section 40 05 13 - Common Work Results for Process Piping: Execution requirements for piping specified by this Section.
4. Section 40 05 51 - Common Work Results for Process Valves: Execution requirements for valves specified by this Section.
5. Section 40 05 51.15 - Gate Valves: Execution requirements for gate valves as required by this Section.
6. Section 40 05 51.24 - Check Valves: Execution requirements for check valves as required by this Section.
7. Section 40 05 78 - Miscellaneous Valves: Execution requirements for miscellaneous valves as required by this Section.
8. Section 43 21 13 - Centrifugal Liquid Pumps: Horizontal, vertical, and screw centrifugal pumps.

#### 1.2 REFERENCE STANDARDS

##### A. American Society of Mechanical Engineers:

1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
2. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
3. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

- B. NSF International:
  - 1. NSF 61 - Drinking Water System Components - Health Effects.
  - 2. NSF 372 - Drinking Water System Components - Lead Content.
- C. Occupational Safety and Health Administration (OSHA):
  - 1. 29 CFR 1910 - Occupational Safety and Health Standards.

### 1.3 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate Work of this Section with location and placement of utilities and piping.

### 1.4 PREINSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum two weeks prior to commencing Work of this Section.

### 1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
  - 1. Submit Manufacturer information for:
    - a. Drive assemblies, pumps, tanks, mixers, panels, and other major components.
    - b. Schematics, diagrams, panel layouts, ladder diagrams, and sequence of operation.
    - c. Electric motors and variable-frequency drives.
- C. Shop Drawings:
  - 1. Indicate assembly, foundation, and installation with location including critical dimensions, sizes, and support locations.
  - 2. Characteristic Pump Curves: Plot against flow rate and indicate total dynamic head, pump efficiency, brake horsepower, net positive suction head, power input to motor, and overall efficiency.
  - 3. For multi-speed service, indicate characteristic curves for maximum and minimum speeds specified.
  - 4. Submit pump name, identification tag number, and Specification Section number.
  - 5. Submit elevation of local control panel, indicating panel-mounted devices, power single-line diagram, and input/output list.
  - 6. Submit electrical schematic diagram and wiring diagram of field connections.

- D. Manufacturer's Certificate:
  - 1. Certify that pumping systems meet or exceed specified requirements.
  - 2. Pumping Systems Rated Greater than 5 hp (3.7 kW):
    - a. Certify that pumping system has been installed satisfactorily and is ready for operation.
    - b. Indicate date of field tests and furnish test data.
- E. Test and Evaluation Reports:
  - 1. Performance Data Curves:
    - a. Indicate head, flow rate, power demand, net positive suction head (NPSH) required, and pump efficiency over entire operating range of pump.
    - b. Indicate head, power demand, overall efficiency at design, and maximum and minimum flow rates.
    - c. For variable-frequency-driven pumps, indicate performance at intervals of 100 rpm from minimum to maximum speed.
  - 2. NPSH:
    - a. Indicate test results of NPSH required, as required by specific pump Section.
    - b. Otherwise, submit Manufacturer's NPSH calculation.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Qualifications Statements:
  - 1. Submit Manufacturer's approval of installer.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Spare Parts:
  - 1. Furnish one set of Manufacturer's recommended spare parts.
- C. Tools: Furnish special wrenches and other devices required for Owner to maintain and calibrate pumping systems.

#### 1.7 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

## 1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by Manufacturer.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- C. Store materials according to Manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to Manufacturer instructions.

## 1.10 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

## 1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five-year Manufacturer's warranty for pumping systems.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Provide pumping systems designed and constructed for continuous service within specified range of operation, without overheating, cavitation, or excessive vibration.

### 2.2 LUBRICATION

- A. Water-Lubricated Pumps: Provide flow meter and differential pressure switch to de-energize pumping unit in low-water-flow conditions.
- B. Ball Bearings and Roller Bearing: Lubricate materials as recommended by Pump Manufacturer.
- C. Lubrication Equipment: Provide pumps, piping, tankage, and filters as required to supply lubrication to pumping units.

## 2.3 PUMP PIPING, FITTINGS, AND VALVES

- A. For piping, fittings, and valves furnished with pumps, comply with relevant Section referenced in this Section under "Related Requirements" Paragraph.

## 2.4 PIPING CONNECTIONS

- A. Flanges:
  - 1. Comply with ASME B16.1.
- B. Fasteners:
  - 1. As specified in Section 05 50 00 - Metal Fabrications.
- C. Screwed Fittings: Comply with ASME B1.20.1.

## 2.5 SHAFT COUPLING GUARDS

- A. Comply with OSHA requirements.

## 2.6 FINISHES

- A. As specified in Section 09 91 20 - Painting and Coating.

## 2.7 ACCESSORIES

- A. Nameplates:
  - 1. Identify individual pumps with a stainless-steel nameplate, indicating assigned equipment number, serial number, rated head and flow rate, impeller size, speed, and Manufacturer's name and model number.

## 2.8 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Drive Units:
  - 1. Test electric drive motors as specified in Division 26.
  - 2. Test variable-frequency drives as specified in Section 26 29 23 - Variable-Frequency Motor Controllers.
  - 3. Furnish test results to Pump Manufacturer prior to pump testing.
- C. Hydrostatic Testing:
  - 1. Hydrostatically test each pump.
  - 2. Provide Architect/Engineer minimum two weeks' notification prior to testing.
  - 3. Perform witnessed hydrostatic and performance tests on pumps where specified.

4. Test Pressure:
  - a. Centrifugal Pumps: Minimum 150 percent of shutoff head.
  - b. Positive Displacement Pumps: Minimum 150 percent of maximum head.
- D. Performance Testing (Non-positive-displacement Pumps):
  1. Test over entire operating range of pump; obtain measurements of head, flow rate, power demand, NPSH required, and pump efficiency.
  2. Obtain measurements of head, maximum and minimum flow rates, power demand, and overall efficiency at design.
  3. For variable-frequency-driven pumps, test pumps at intervals of 100 rpm from minimum to maximum speed.
  4. Demonstrate that pump is free from overheating, cavitation, and excessive vibration overflow rate range.
  5. For centrifugal pumps, demonstrate no contact between impeller ring and casing ring overflow rate range.
- E. Performance Testing (Positive-Displacement Pumps):
  1. Operate pump at least 30 minutes for each specified speed and capacity to demonstrate compliance with specified requirements and to establish that pumping unit is free from overheating and excess vibration.
  2. Test pump at maximum rated speed and at minimum, rated, and maximum flow rates, and measure respective head and ampere draw.
- F. Drive Units:
  1. Perform tests using complete pump system to be furnished, including Project motor and variable-frequency drive.
  2. For pumps with motors rated less than 100 hp (74 kW), Manufacturer's certified test motor is acceptable.
- G. Do not ship equipment until test data have been accepted by Architect/Engineer.
- H. Certificate of Compliance:
  1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
  2. Specified shop tests are not required for Work performed by approved fabricator.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

### 3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Disconnect electrical systems scheduled for removal.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction.
- D. Remove, relocate, and extend existing installations as necessary to accommodate new construction.

### 3.3 INSTALLATION

- A. According to Manufacturer instructions.
- B. Ensure that equipment is secure in position.
- C. Equipment Bases and Supports:
  - 1. Provide housekeeping pads of concrete as indicated on Drawings.
  - 2. Install anchor bolts and accessories for mounting and anchoring equipment.
  - 3. Supports:
    - a. Construct supports of steel members.
    - b. Brace and fasten with flanges bolted to equipment structure.
    - c. Provide flexible connections as required to isolate equipment from piping.
- D. Gauges:
  - 1. Provide pressure gauges at pump discharge piping and compound gauges on pump suction piping.
  - 2. If subject to shock or vibrations, wall-mount gauges or attach gauges to galvanized channel floor stands and connect with flexible connectors.
- E. Lubricants: Provide necessary oil and grease for initial operation.
- F. Coat materials and equipment as specified in Section 09 90 21 - Painting and Coating.

### 3.4 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Testing:
  - 1. Test for proper alignment and freedom from binding, scraping, shaft runout, or other defects.
  - 2. Where specified by individual Specification Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
  - 3. Engineer will witness field testing.
  - 4. Start control system by energizing system equipment and testing operation of hardware and process control logic under supervision of Manufacturer's representative and in presence of Engineer.
  - 5. Field-test each pump system after installation in order to demonstrate:
    - a. Satisfactory operation without excessive noise and vibration overflow rate range; if pump driven by variable-frequency drive, test at 100-rpm increments.
    - b. Required head, flow rate, and efficiency at design point.
  - 6. Certify in writing that pump system has been satisfactorily tested.
- C. Manufacturer Services: Furnish services of Manufacturer's representative experienced in installation of products furnished under this Section for not less than seven days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.
- D. Equipment Acceptance:
  - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
  - 2. Make final adjustments to equipment under direction of Manufacturer's representative.
- E. Furnish installation certificate from Equipment Manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

### 3.5 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION



## SECTION 43 21 00 - LIQUID PUMPS GENERAL

### 1.1 SUMMARY

- A. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated.
- B. Where two or more pump systems of the same type or size are required, all pumps shall all be produced by the same Manufacturer.
- C. Provide all labor, equipment and materials and perform all operations in connection with the installation and testing of pumps selected by the Owner.
- D. Coordinate and utilize all factory testing, installation, start-up, and field-testing services supplied in conjunction with the pumping equipment.
- E. All work performed under this Section shall be in accordance with all approved trade practices and Manufacturer's recommendations.
- F. Section includes:
  - 1. General pump material, components and appurtenances for liquid pumps.
  - 2. Quality control factory and field testing.
- G. Related Sections:
  - 1. Section 09 90 21, Painting and Coating
  - 2. Section 26 29 23, Variable-Frequency Motor Controllers
  - 3. Section 43 21 13, Centrifugal Liquid Pumps

### 1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers (ASME):
  - 1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
  - 2. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - 3. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- B. NSF International:
  - 1. NSF 61 - Drinking Water System Components - Health Effects.
  - 2. NSF 372 - Drinking Water System Components - Lead Content.
  - 3. NSF 600 - Health Effects Evaluation and Criteria for Chemicals in Drinking Water.

### 1.3 COORDINATION

- A. Section 01 30 00, Administrative Requirements: Requirements for coordination.
- B. Coordinate Work of this Section with location and placement of utilities and piping.

### 1.4 PREINSTALLATION MEETINGS

- A. Section 01 30 00, Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week, prior to commencing Work of this Section.

### 1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Provide the following information:
  - 1. Pump name, identification number, and applicable Section number from Project specifications.
  - 2. Performance Data Curves:
    - a. Provide performance curve showing head, capacity, horsepower demand, net positive suction head (NPSH) required and pump efficiency over the entire operating range of the pump.
    - b. Pump Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.
    - c. A family of performance curves at intervals of 100 revolutions per minute (rpm) from minimum speed to maximum speed shall be provided for each pump equipped with a variable speed drive, and a curve for each speed on two-speed pumps.
  - 3. The limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration, known as the Acceptable Operating Range (AOR), per the Hydraulic Institute.
  - 4. Assembly and Installation Drawings: Including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
- C. All pump motor information as required in Division 26, including complete motor nameplate data as defined by NEMA, motor manufacturer and any motor modifications.
- D. Head lateral analysis as specified herein and where required by individual pump sections.
- E. Provide lateral and torsional analysis as specified herein and where required by individual pump specifications.
- F. Operation and Maintenance Manual: Containing the required information for each pump section.

- G. Spare Parts List: Containing the required information for each pump section.
- H. Factory Test Data: Signed, dated, and certified for each pump system which requires factory testing submitted before shipment of equipment. Requirements for factory test data are specified below.
- I. Certifications:
  - 1. Manufacturer's certification of proper installation.
  - 2. Contractor's certification of satisfactory field testing.
- J. All pump motor information as required in Division 26.
- K. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- L. Certificate of Compliance:
  - 1. Submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. See Section 01 78 23, Operation and Maintenance Data for requirements.

#### 1.7 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

#### 1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by Manufacturer.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00, Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.
- C. Store materials according to Manufacturer instructions.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to Manufacturer instructions.

#### 1.10 EXISTING CONDITIONS

- A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

#### 1.11 WARRANTY

- A. Section 01 70 00, Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one-year Manufacturer's warranty for pumping systems.

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. Materials and equipment shall be standard products of a manufacturer and distributor regularly engaged in the manufacture and distribution of such products for at least [2] years and shall be suitable for the service intended.
- B. All materials and equipment shall be new and unused except for the testing specified herein.
- C. Compliance with the requirements of the individual pump sections may necessitate modifications to the Manufacturer's standard equipment.
- D. All centrifugal pumps shall have a continuously rising performance curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine or encroach on the service factor.
- E. All components of each pump system provided under the pump sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.
- F. The pumps shall be warranted by the Manufacturer for a minimum of 1-year from the date of installation.
- G. The pumping units shall all be supplied by one vendor (unit responsibility) and shall be complete including pumps, motors, column assemblies, suction cans, baseplates, couplings, guards, and other accessories.
- H. The complete pump assembly shall be designed and built for continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.

#### 2.2 MATERIALS

- A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect

the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Casings, Class 30, or equal.
2. Stainless steel pump shafts shall be Type 416 or 316.
3. Miscellaneous stainless steel shall be of Type 316, except in a septic environment.
4. Anchor bolts, washers, and nuts supplied by the Contractor for non-corrosive applications shall be galvanized steel in accordance with the requirements of Section 05 50 00, Metal Fabrications. Anchor bolts, washers, and nuts in corrosive service applications shall be stainless steel in accordance with that Section.

### 2.3 PUMP COMPONENTS, GENERAL

- A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 12, 125, 250, and 800 or B16.5 - Flanges and Flanged Fittings dimensions.
- B. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

### 2.4 PUMP APPURTENANCES

- A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number.

### 2.5 SHAFT COUPLING GUARDS

- A. Comply with OSHA requirements.

### 2.6 FINISHES

- A. As specified in Section 09 90 00, Painting and Coating.

### 2.7 SOURCE QUALITY CONTROL

1. Acceptance: In the event of failure of any pump to meet any of the requirements, the Contractor and Pump Manufacturer shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the pump shall be retested at no additional cost to the Owner until found satisfactory.
- B. Lateral and Torsional Analysis
  1. Where specified in the individual pump sections, the Pump Manufacturer with system responsibility shall perform a complete lateral and torsional analysis of each distinct pump-motor system to be provided on this Project.
  2. This analysis shall identify the dry and wet lateral critical and the torsional critical speeds.

3. This analysis shall be performed prior to fabrication of the machinery and shall be submitted for review as part of the pump submittal.
  4. The pump and motor manufacturers shall furnish detailed mass elastic data to the Engineer, to be used for an independent evaluation of the lateral and torsional natural frequency analysis.
- C. Head Lateral Analysis
1. Where specified in the individual pump sections, the pump manufacturer with system responsibility shall perform a complete head lateral analysis of each distinct pump-motor system that analyzes the head and motor combination.
  2. This analysis shall include a Finite Element Analysis (FEA) to determine the natural frequencies of the above grade head and motor assembly, assuming a rigid foundation. The analysis shall show that the natural frequencies do not encroach within plus or minus 25 percent of any normal operating speed.
- D. Drive Units:
1. Test electric drive motors as specified in Division 26.
  2. Test variable-frequency drives as specified in Division 26.
  3. Perform tests using complete pump system to be furnished, including Project motor and variable-frequency drive, if specified above.
  4. Furnish test results to Pump Manufacturer prior to pump testing.
- E. Do not ship equipment until test data have been accepted by Engineer.

## PART 3 EXECUTION

### 3.1 SERVICES OF PUMP MANUFACTURER

- A. As part of this construction contract, the Contractor shall utilize the full value of the Owner-acquired services for start-up and testing services from the Pump Supplier.
- B. An authorized service representative of the Manufacturer shall visit the Site to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:
  1. Installation of the equipment.
  2. Inspection, checking, and adjusting the equipment.
  3. Startup and field testing for proper operation.
  4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.
  5. Requirements are more specifically detailed herein and in individual pump specifications.

C. Instruction of the Owner's Personnel:

1. An authorized training representative of the Manufacturer shall visit the Site to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.
2. Instruction shall be specific to the models of equipment provided.
3. The Pump Manufacturer's representative shall have at least 2 years' experience in training.
4. Training shall be scheduled a minimum of 3 weeks in advance of the first session.
5. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the training materials.
6. The training materials shall remain with the trainees.
7. The Owner may digitally record the training for later use with the Owner's personnel.

3.2 EXAMINATION

- A. Section 01 70 00, Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

3.3 PREPARATION

- A. Section 01 70 00, Execution and Closeout Requirements: Requirements for installation preparation.
- B. Disconnect electrical systems scheduled for removal.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction.
- D. Remove, relocate, and extend existing installations as necessary to accommodate new construction.

3.4 INSTALLATION

- A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.
- B. Alignment:
  1. All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects.
  2. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing.

3. Equipment shall be secure in position and neat in appearance.
- C. Equipment Bases and Supports:
1. Provide pump bases as shown on Drawings.
  2. Install anchor bolts and accessories for mounting and anchoring equipment.
  3. Supports:
    - a. Construct supports of steel members.
    - b. Brace and fasten with flanges bolted to equipment structure.
    - c. Provide flexible connections as required to isolate equipment from piping.
- D. Provide rigid anchors for pipes after vibration isolation components are installed, as specified in Section 43 05 48, Vibration and Seismic Controls for Process Gas and Liquid Handling Equipment.
- E. Lubricants: Provide the necessary lubricants for initial operation, as required by individual pump sections or as recommended by the Manufacturer.

### 3.5 FIELD TESTS

- A. Engineer shall be notified of witness field testing and shall witness portions of the testing, as determined by the Engineer.
- B. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.
- C. Test for proper alignment and freedom from binding, scraping, shaft runout, or other defects.
- D. Field testing methods and allowable tolerances shall comply with current version of the Hydraulics Institute standards for the type of pumps installed.
- E. The following field testing shall be conducted:
1. Startup, check, and operate the pump system over its entire speed range. Where vibration analysis and measurement are required, it shall be within the amplitude limits specified and recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
  2. Obtain concurrent readings of motor voltage, amperage, pump suction head and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
  3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test unless insufficient liquid volume is available.
  4. Electrical and instrumentation tests shall conform to the requirements of the Section under which that equipment is specified.



5. Field vibration readings shall be conducted by an Owner-selected certified testing agency, paid for by the Contractor, with readings taken at the following positions with the average not exceeding the current Hydraulic Institutes standards for the type of pump installed.
    - a. Measurements shall be taken at the locations as specified in the current Hydraulic Institute standards for the type of pump installed. Provide written proof of vibration readings and provide test data.
  6. Sound test not to exceed 83 dbA at 3 feet from motor in any direction.
- F. Field testing will be witnessed by the Engineer. The Contractor shall furnish 3 days' advance notice of field testing.
- G. Equipment Acceptance:
1. Acceptance shall include a comparison of measured installed pump performance with the Manufacturer's curve values. Any discrepancy shall be resolved prior to acceptance by the Owner.
  2. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests until the performance is verified.
  3. Make final adjustments to equipment under direction of Manufacturer's representative.
  4. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.
- H. Contractor shall bear all costs of field tests, including additional services of the Manufacturer's representative required beyond those specified.

### 3.6 DEMONSTRATION

- A. Section 01 70 00, Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION

## SECTION 43 21 13 - CENTRIFUGAL LIQUID PUMPS

### PART 1 GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Horizontal end suction pumps.
2. Horizontal non-clog pumps.
3. Horizontal recessed impeller pumps.
4. Horizontal split-case pumps.
5. Horizontal axial-flow pumps.
6. Vertical non-clog pumps.
7. Screw centrifugal pumps.

##### B. Related Sections

1. Section 26 05 03 - Equipment Wiring Connections: Conduit and electrical power to pumps.
2. Section 26 29 23 - Variable-Frequency Motor Controllers: Execution and product requirements for equipment specified by this Section.
3. Section 40 05 13 - Common Work Results for Process Piping: Execution requirements for piping specified by this Section.
4. Section 40 05 23 - Common Work Results for Process Valves: Execution requirements for valves specified by this Section.
5. Section 43 05 20 - Common Work Results for Liquid Handling Equipment: Pump components, appurtenances, and identification requirements common to liquid-handling systems.

#### 1.2 REFERENCE STANDARDS

##### A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

##### B. American Society of Mechanical Engineers:

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.

##### C. ASTM International:

1. ASTM A322 - Standard Specification for Steel Bars, Alloy, Standard Grades.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM A606 - Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.
4. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.

### 1.3 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation and startup of Work of this Section with Owner's operations.

### 1.4 SCHEDULING

- A. Schedule Work of this Section to install pumps prior to connecting piping work.

### 1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit information concerning materials of construction and fabrication.
- C. Shop Drawings:
  1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
  2. Include Manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.
- D. Product Data: Submit information concerning materials of construction and fabrication.
- E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports: Indicate that equipment has been installed according to Manufacturer's instructions.

### 1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
- B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

- C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

## 1.7 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

## PART 2 PRODUCTS

### 2.1 VERTICAL PUMPS

- A. Pump to be Owner-Furnished, Contractor-Installed. Refer to appendix for proposed pump shop drawings.
- B. Description: Centrifugal, vertical non-clog pump, with vertical hollow shaft electric motor.
- C. Performance and Design Criteria:
  - 1. Design Flow Rate: 110 gpm
  - 2. Design Flow Total Dynamic Head: 260 feet.
  - 3. Minimum Efficiency at Design Flow Rate: 72 percent.
  - 4. NPSH Available: 4.4 feet.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install pumps where indicated on Drawings and in accordance with Manufacturer's instructions.
- B. Provide and connect piping, power, and control conduit, and wiring to make system operational and ready for startup.
- C. Flush piping with clean water.

### 3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Pre-operational Check: Before operating system or components, perform the following:
  - 1. Check pump and motor alignment.
  - 2. Check for proper motor rotation.
  - 3. Check pump and drive units for proper lubrication.
- C. Startup and Performance Testing:

1. Operate pump on clear water at design point for continuous period of two hours, under supervision of Manufacturer's representative and in presence of Architect/Engineer.
- D. Verify pump performance by performing time-drawdown test or time-fill test.
- E. Check pump and motor for high bearing temperature and excessive vibration in accordance with the Manufacturer's recommendations. Check for motor overload by taking ampere readings.
- F. Equipment Acceptance:
1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests. Make final adjustments to equipment under direction of Manufacturer's representative.

END OF SECTION

APPENDIX A – PROPOSED PUMP SUBMITTAL

**\*\* Submittal for Approval \*\*****PROJECT**

Thornton PS  
Xylem Goulds Vertical Turbines

**SUPPLIER**

Cogent Companies  
14452 W. 44th Ave.  
Golden, CO 80403  
303-524-9000

**PUMP MANUFACTURER**

Xylem Lubbock  
4608 Bradley St  
Lubbock, TX 79415

**DENVER**

14452 W. 44TH AVE  
GOLDEN, CO 80403  
303.584.9000 MAIN

**BILLINGS**

2155 HARNISH BLVD.  
BILLINGS, MT 59101  
303.584.9000 MAIN

**CASPER**

625 KRAFT LOOP  
CASPER, WY 82601  
303.584.9000 MAIN

**\*\* Revision 2 Notes \*\***

Total pump length updated in accordance with dimensional information provided by Browns Hill Engineering

**DENVER**

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GOLDEN, CO 80403  
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## PERFORMANCE ON DESIGN CURVE AT 1770 RPM

	Shut Off	Design [2]	Run Out [5]		
Flow (USGPM)	0.0	110.0	160.0	Best Efficiency	76.70 % at 111.0 USgpm
TDH-Bowl (ft)	369.0	268.0	156.0	Design Flow % BEP	99.10 %
TDH-Disch Flange ( ft)	360.2	259.1	147.0	Pump Efficiency	75.59 %
Bowl Efficiency (%)	-	76.60	63.60	Overall Efficiency	69.85 %
Guaranteed Bowl Efficiency (%)	-	72.77	-	NOL Power	10.1 Hp at 135.0 USgpm
Power (Hp)	6.1	9.7	9.9	Specified NPSH Ratio	1.1
Guaranteed Power (Hp)	-	10.5	-	Thrust Load Power Loss	0.10474 Hp
NPSHr (ft) [1]	-	4.4	6.9	Total Flow Derate Factor	1.00
NPSH Margin (ft) [1]	-	23.3	20.8	Total Head Derate Factor	1.00
Hydraulic Thrust(lb)	970.0	705.0	411.0	Total Efficiency Derate Factor	1.00
Thrust (lb)	1106.2	826.9	517.1	Actual Submergence	18.37 in
Pressure-Bowl (psi)	159.7	116.0	67.5	Shaft Friction Power Loss	0.02 Hp
Pressure-Disch Flange (psi)	156.0	112.2	63.6	Min Flow (MCSF)	27.8 USgpm
Min Submergence (Inch) [3]	-	10.30	12.08	kWh per 1000 gal	1.20479
Friction Loss (ft) [4]	-	0.14	0.30	Impeller Running Clearance	0.06 in
Lineshaft Elongation (Inch)	0.00190	0.00138	-		
Column Elongation (Inch)	0.00017	0.00012	-		
Lateral (Inch)	0.06173	0.06126	-		

[1] at 1st impeller eye [2] rated values [3] from pump suction inlet [4] from bowl to disch flange [5] per published data

## OPERATING CONDITIONS

Specified Flow	110.00 USgpm
Specified TDH	260.00 ft
Rated Speed	1770 RPM
Atmospheric Pressure	11.78 psi
TPL	11.80 ft
Pumping Level	7.00 ft
NPSHa at 1st Impeller	27.7 ft
NPSHa at Grade	27.2 ft
Operational Design	Constant Speed

## FLUID CHARACTERISTICS

Fluid	Water
Fluid Temperature	68.0 °F
Specific Gravity	1.0000
Viscosity	1.0017 cP
Vapor Pressure	0.3393 psi
Density	62 lbs/ft <sup>3</sup>

## MATERIALS & DIMENSIONS

### Bowl Data

Bowl Material	Cast Iron with Glass Enamel
Impeller Material	316SS
Bowshaft Material	416SS
Impeller Attachment	Taper Lock
Taperlock Material	Carbon Steel
Discharge Bowl Material	Cast Iron
Suction Type	Bell
Suction Material	Cast Iron
Bowl Bolting Material	Carbon Steel
Sand Collar	304SS
Pipe Plug	Iron
Suction Bearing	Bronze
Discharge Bowl Bearing	Bronze

### Bowl Data

Intermediate Bowl Bearing	Bronze
Strainer Type	Clip-On Bell Type Strainer
Strainer Material	Galvanized Steel
Impeller Trim	5.31 in
Bowl Pressure Limit	430 psi
Model Max Sphere Size	0.38 in
Available Lateral	0.37 in
Bowl Shaft Diameter	1 3/16 in [30.2 mm]
Impeller Balance	Manufacturer's Standard
Impeller Design	Enclosed
Bowl Shaft Power Limit	124.68 Hp
Bowl Assembly Provided By	Xylem

### Bowl Specials

## CERTIFIED SUBMITTAL – REV1

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	

### Column Data

Column Type	Threaded
Column Diameter	4 in [102 mm]
Lineshaft Diameter	1 in [25.4 mm]
Column Pipe Material	Carbon Steel
Lineshaft Material	416SS
Lineshaft Bearing Material	Rubber (Dog Bone)
Lineshaft Coupling Type	Threaded
Lineshaft Coupling Material	416SS
Column Loss	0.06 ft
Column Velocity	2.95 ft/s
Separate Bearing Retainer	304SS
Bearing Retainer Design	Separate
Maximum Bearing Spacing	5 ft [1.5 m] Spacing
Max Column Section Length	60 in

### Column Data

First Lateral Critical Speed	2704 RPM
First Lateral Critical Speed Ratio	1.53
Second Lateral Critical Speed	10413 RPM
Second Lateral Critical Speed Ratio	5.88
Column Wall Thickness	0.24 in
Lubrication Method	(Open LS) Product Lube
Lineshaft Power Limit	70 Hp
Column Assembly Provided By	Xylem

### Column Specials

### Head Data

Head Type	DI (Ductile Iron)
Discharge Flange Rating	150 #
Disch Flange Pressure Limit	250 psi
Head Design	One Piece Head
Discharge Head Material	Ductile Iron
Headshaft Material	416SS
Headshaft Coupling Type	Threaded
Headshaft Coupling Material	416SS
Headshaft Diameter	1.00 in
Discharge Head Size	4 in [102 mm]
Discharge Head BD	12 in [305 mm]
Sealing Method	Mechanical Seal

### Head Data

Mechanical Seal	Chesterton 155 1DCW
Seal Provided By	Xylem
Seal Mounted By	Customer
Stuffing Box / Seal Hsg Bolt	316SS
Stuffing Box / Seal Hsg Brg	Bronze
Seal Housing Material	Cast Iron
Steel Sub Base	Carbon Steel
Head Loss	0.10 ft
Head Bolting	Carbon Steel
Head Assembly Provided By	Xylem

### Head Specials

### Motor Data

Driver Type	Vertical Hollow Shaft Motor
Manufacturer	US
HP Rating	15 Hp
Speed [Poles]	1800 rpm [4 pole]
Voltage	230/460 V
Phase / Frequency	3 PH / 60 Hz
Enclosure	TEFC Corro-Duty
Efficiency / Config	Premium
Motor Efficiency	92.40 %
Motor Frame	254TPH
BD	12.0 in
BX / U	1.00 in

### Motor Data

Thrust Level	100% HT
Thrust Capacity	3300 lbs
Inverter Duty	Yes
Steady Bushing	No
Coupling	NRR w/ Steady Bushing
SF** / Insulation	1.15 H
Mfg Catalog Number	CHT15V2BLE-C
Motor Part Number	H015B2A1FB-CVNU-100A0B000
Motor Provided By	Xylem
Motor Mounted By	Customer

### Motor Specials

## CERTIFIED SUBMITTAL – REV1

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	



# SUBMITTAL

Quote ID: 9001-220803-046:0:1 QTY: 1  
VIT-DITM 7WALC, 12 Stages

## Coating Data

<b>Bowl OD</b>	Goulds Water Technology Blue Enamel
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## Coating Data

<b>Column OD</b>	Goulds Water Technology Blue Enamel
<b>Head OD</b>	Goulds Water Technology Blue Enamel

## Testing Data

## Accessories

## Engineering Services

## Engineering Services Notes

## Miscellaneous Specials

## Assembly and Crating

<b>Assembly</b>	Fully Assembled
<b>Crating</b>	Domestic Skid

## Assembly and Crating Notes

In general, pumps are crated and shipped fully assembled\* via standard freight methods (LTL/LCL) if overall crated length is 25 ft or less and weight is 2500 lbs or less. Up to 45 ft and 4000 lbs can still be fully assembled but will ship via dedicated freight methods (FTL/FCL/flatbed/air/special). Otherwise, each sub-assembly (bowl, column, and head) is crated separately ("column loose"). \*Motors, suction cans, mechanical seals, spare parts, and other special items are crated separately. Coordinate specific expectations with the factory at time of order.

## Weight Data

<b>Total Bowl Weight</b>	391 lbs
<b>Total Column Weight</b>	96 lbs
<b>Head Weight</b>	120 lbs

## Weight Data

<b>Motor Weight</b>	395 lbs
<b>Total Weight</b>	1002 lbs

## Comments

## INFO, WARNING & ERROR MESSAGES

### CERTIFIED SUBMITTAL – REV1

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	



# SUBMITTAL

Quote ID: 9001-220803-046:0:1 QTY: 1  
VIT-DITM 7WALC, 12 Stages

Our offer does not include specific review and incorporation of any Statutory or Regulatory Requirements, and the offer is limited to the requirements of the design specifications. Should any Statutory or Regulatory requirements need to be reviewed and incorporated, then the Customer is responsible to identify those and provide copies for review and revision of our offer.

Our quotation is offered in accordance with our comments and exceptions identified in our proposal and governed by our standard terms and conditions of sale – Xylem Americas attached hereafter.

For units requiring a factory performance test, all performance tests will be conducted per ANSI/HI 14.6 standards unless otherwise noted. As a standard, test results for the primary design point meeting grade 2B tolerances for pumps with a rated shaft power of 134 hp or less and grade 1B for greater than 134 hp will be considered passing. If secondary or tertiary design points are required to be tested, these will be subject to grade 3B tolerances. For testing of more than 3 points, consult the factory. Other acceptance grades are available and must be clearly noted and mutually agreed upon between the Customer and Xylem before release to manufacture.

Holding shipment for testing approval allows 2 weeks of production lead time for the approval process, after which Xylem reserves the right to ship passing pumps without explicit approval. For approval processes exceeding 2 weeks, please consider that additional lead time and coordinate expectations with the factory. For faster shipment, select "No" to the hold shipment for testing approval option.

For units not requiring a factory performance test, product performance can be expected to meet 3B tolerances primarily due to the variability of field conditions. Field-measured performance may vary from factory-measured performance or published data as a result of unknown or unpredictable system conditions and measurement variability. If field performance testing is required after installation, factory performance testing before shipment is strongly recommended. Field performance test results do not constitute a warranty claim unless verified by Xylem.

The information provided in this submittal is published data nominally representative of the selected pump model's performance characteristics. If factory performance testing is included, actual as-tested performance curves for each tested pump will be provided after testing is complete. Impeller trim diameter is subject to change to meet intended design conditions.

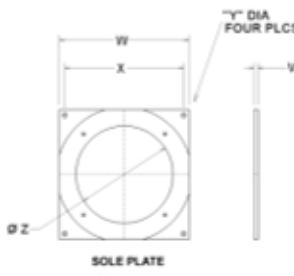
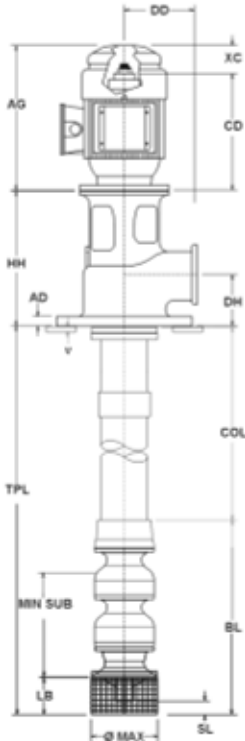
Customer is responsible for verifying that the recommendations made and the materials selected are satisfactory for the Customer's intended environment and Customer's use of the selected pump. Customer is responsible for determining the suitability of Xylem recommendations for all operating conditions within Customer's and/or End User's control. Xylem disclaims all warranties, express or implied warranties, including, but not limited to, warranties of merchantability and fitness for a particular purpose, and all express warranties other than the limited express warranty set forth in the attached standard terms and conditions of sale – Xylem Americas attached hereafter.

Xylem does not guarantee any pump intake configuration. The hydraulic and structural adequacies of these structures are the sole responsibility of the Customer or his representatives. Further, Xylem accepts no liability arising out of unsatisfactory pump intake field operating conditions. The Customer or his representatives are referred to the Hydraulic Institute Standards for recommendations on pump intake design. To optimize the hydraulic design of a field pump intake configuration, the Customer should strongly consider performing a detailed scale model pump intake study. However, the adequacies of these recommendations are the sole responsibility of the Customer.

Xylem's standard enamel paint offering is a coating applied at no extra charge and is intended to provide a limited cosmetic improvement over the bare metal product. The coating will not prevent rust, corrosion, or fading. Fading, flaking, chipping, or bleeding rust can be expected within 3 months of exposure to weather or other elements. For applications where visual aesthetics or corrosion resistance is important, please consider one of our protective coating options.

## CERTIFIED SUBMITTAL – REV1

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	



**DIMENSIONS**

Dim G [Mounting Flange Dia]:	16.00 in
J [Mounting Flange Hole Dia]	0.75 in
K [Mounting Hole Places]	4
H [Mounting Flange Bolt Circle]	14.25 in
AG [Motor Height]	28.63 in
CD [Motor Coupling Height]	22.94 in
XC [Top Hdshft to top VHS Motor]	5.50 in
BD [Motor Base Dia]	12.00 in
Discharge Head Size	4.00 in
BD Head [Discharge Head Base Dia]	12.00 in
HH [Head Height]	17.00 in
AD [Mounting Flange Thickness]	0.61 in
DD [Disch Flange Stickout]	8.25 in
DH [Disch Flange Height]	9.00 in
R [Hanger Flange OD]	5.00 in
Column Length (COL)	64.34 in
COL [Column Diameter]	4.00 in
TPL [Total Pump Length]	141.60 in
MIN SUB [Minimum Submergence]	10.30 in
LB [Length to Bottom]	5.63 in
MAX [Max Assembly OD]	7.63 in
BL [Bowl Assembly Length]	77.26 in
V [Sub Base Thickness]	0.75 in
W [Sub Base Overall Size]	18.00 in
X [Center Line of Holes]	16.00 in
Y [Mounting Holes Base Plate Dia]	0.63 in
Z [Base Plate Opening or Can ID]	12.00 in
SU [Shaft Stickup]	8.00 in
SL [Suction Length]	1.88 in
Discharge Flange	4*-150#

**PUMP DATA**

<b>Column Diameter</b>	4 in [102 mm]
<b>Lineshaft Diameter</b>	1 in [25.4 mm]
<b>Specified Flow</b>	110.00 USgpm
<b>Specified TDH</b>	260.00 ft
<b>Pumping Level</b>	8.00 ft
<b>Motor Manufacturer</b>	US
<b>Driver Type</b>	Vertical Hollow Shaft Motor
<b>Selected Motor Power</b>	15.00 Hp
<b>Motor Speed</b>	1770 RPM
<b>Phase / Frequency</b>	3 PH / 60 Hz
<b>Voltage</b>	230/460 V

**WEIGHTS**

<b>Total Bowl Weight</b>	391 lbs
<b>Total Column Weight</b>	96 lbs
<b>Head Weight</b>	120 lbs
<b>Motor Weight</b>	395 lbs
<b>Total Weight</b>	1002 lbs

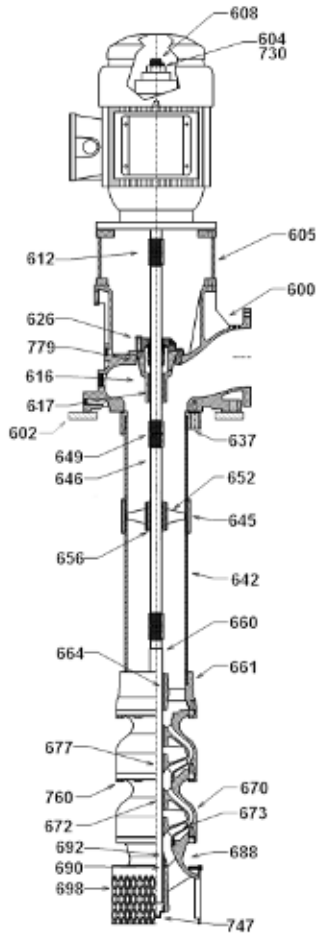
**NOTES**

- 1 Total Pump Length ± 1.0 inch.
- 2 Tolerance on all dimensions is .12 or ± .12 inch per 5 ft, whichever is greater.
- 3 All dimensions shown are in inches unless otherwise specified.
- 4 Drawing not to scale.
- 5 1/2" NPT – Gauge Conn (plugged)
- 6 Driver may be rotated at 90° intervals about vertical centerline for details refer to driver dimension drawing.
- 7 Refer to product IOM for impeller setting requirements.
- 8 This assembly has been designed so that its natural frequency responses avoid the specific operating speeds by an adequate safety margin. The design has assumed the foundation to be rigid.

**CERTIFIED SUBMITTAL – REV1**

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	



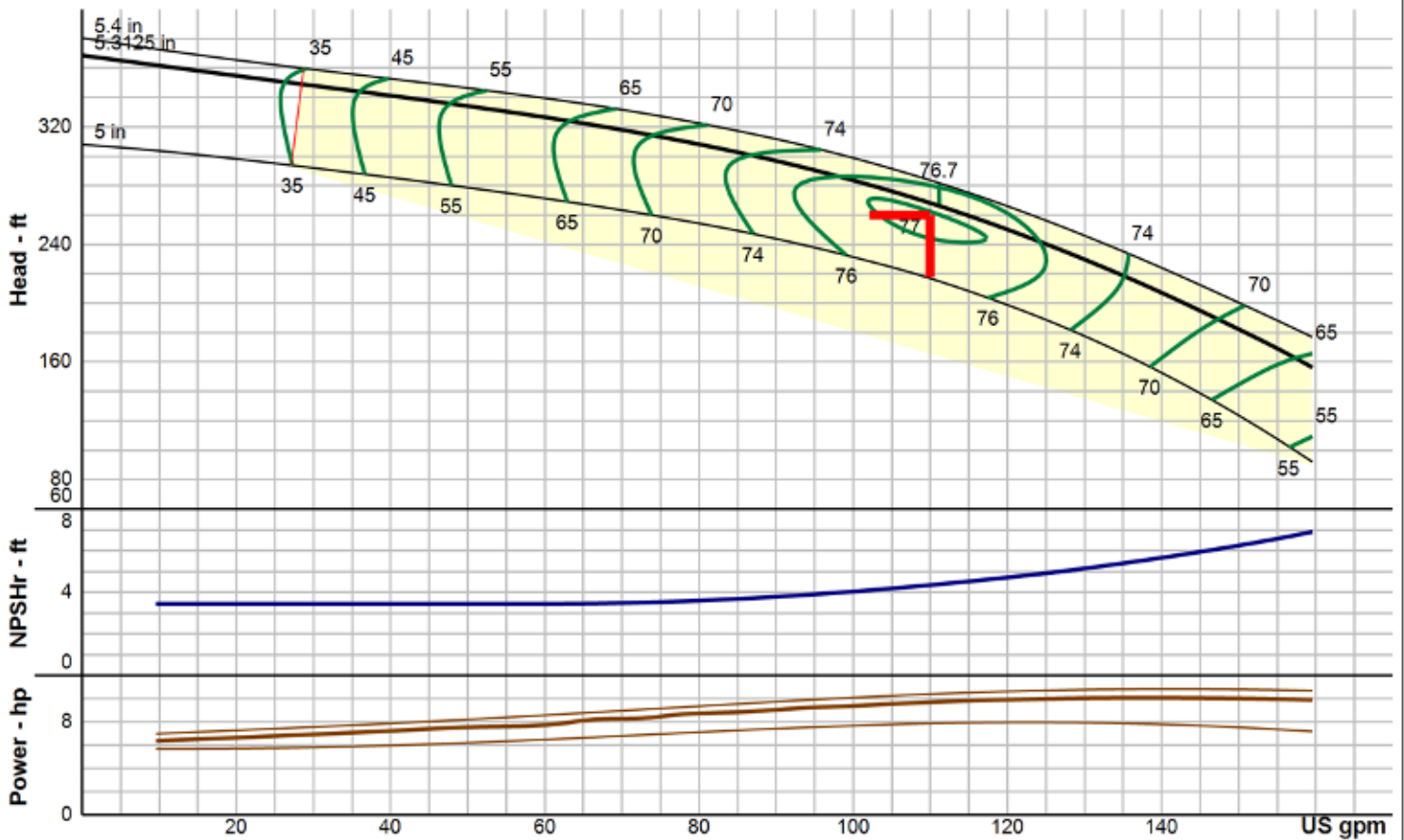


**BILL OF MATERIALS**

ITEM	PART NAME	CODE	MATERIAL	ASTM#
<b>Head Assembly</b>				
608	Headshaft	2227	SST 416	A582 S41600
600	Head - Discharge	1018	Ductile Iron 65-45-12	A536
602	Base - Sub	3201	Carbon Steel GR D	A36M
604	Nut - Adjusting	2242	Carbon Steel 1018	A108
616	Housing - Seal	1003	Cast Iron CL 30	A48 CLASS 30B
617	Bearing - Seal Housing	1618	Bismuth Bronze	B584 Modified
626	Seal - Mechanical	0000	Chesterton 155 1DCW	None
649	Coupling - Headshaft	2265	SST 416	A582M
730	Key - Motor Gib	2242	Carbon Steel 1018	A108
760	Capscrew - Hex	2298	Steel Bolting GR 8	J429
779	Gasket - Housing	5136	Acrylic/Nitrile	5136 REV 4
<b>Column Assembly</b>				
642	Pipe - Column	6501	Black Pipe Sch 40	A53
645	Column - Coupling	6501	Black Pipe Sch 40	A53
646	Lineshaft	2227	SST 416	A582 S41600
649	Coupling - Lineshaft	2265	SST 416	A582M
652	Retainer - Bearing	1205	SST 304	A744M
656	Bearing - Lineshaft	5121	Rubber EPDM	D3568
<b>Bowl Assembly</b>				
660	Bowshaft	2227	SST 416	A582 S41600
661	Bowl - Discharge	1003	Cast Iron CL 30	A48 CLASS 30B
664	Bearing - Discharge Bowl	1618	Bismuth Bronze	B584 Modified
670	Bowl - Intermediate	6911	Cast Iron CL 30 Enamel	A48
672	Bearing - Intermediate Bowl	1618	Bismuth Bronze	B584 Modified
673	Impeller	1203	SST 316	A744M
677	Taperlock - Impeller	2242	Carbon Steel 1018	A108
688	Suction	1003	Cast Iron CL 30	A48 CLASS 30B
690	Bearing - Suction	1618	Bismuth Bronze	B584 Modified
692	Sandcollar	1205	SST 304	A744M
698	Strainer	6952	Carbon Steel Galv	A123M
747	Plug - Pipe	1046	Malleable Iron	A197
760	Capscrew - Hex	2298	Steel Bolting GR 8	J429

**CERTIFIED SUBMITTAL – REV1**

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Project	OP-556186 Thornton Irrigation PS	
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Serial Number	5113518 – REV1	



Curve & hydraulic data presented is nominal performance based on ANSI/HI 14.6 acceptance grade 2B.  
Design values are guaranteed within the following tolerances: Flow  $\pm$  8%, Head  $\pm$  5%, and optionally either Power + 8% or Efficiency - 5% at manufacturer's discretion.

<b>Specified Flow</b>	110.00 USgpm	<b>Shut Off TDH (Disch Flange)</b>	360.3 ft	<b>Recommended Power</b>	15.00 Hp
<b>Specified TDH</b>	260.00 ft	<b>Shut Off Pressure (Bowl)</b>	159.7 psi	<b>Driver Size Criteria</b>	NOL Power Across Design Curve
<b>Rated Speed</b>	1770 RPM	<b>Shut Off Pressure (Disch Flange)</b>	156.0 psi	<b>Allow Service Factor</b>	No
<b>Atmospheric Pressure</b>	11.78 psi	<b>Run Out Flow</b>	160.0 USgpm	<b>kWh per 1000 gal</b>	1.20479
<b>Pumping Level</b>	8.00 ft	<b>Run Out TDH (Bowl)</b>	156.0 ft	<b>NPSHr at Design</b>	4.4 ft
<b>Elevation</b>	6000 ft	<b>Run Out TDH (Disch Flange)</b>	147.0 ft	<b>NPSH Margin at Design</b>	23.3 ft
<b>NPSHa at Grade</b>	27.2 ft	<b>Run Out Pressure (Bowl)</b>	67.5 psi	<b>Min Submergence at Design</b>	10.30 in
<b>NPSHa at 1st Impeller</b>	27.7 ft	<b>Run Out Pressure (Disch Flange)</b>	63.6 psi	<b>Actual Submergence</b>	18.37 in
<b>Fluid</b>	Water	<b>Bowl Efficiency at Design</b>	76.60 %	<b>Thrust K-Factor</b>	2.6 lbpft
<b>Fluid Temperature</b>	68.0 °F	<b>Guaranteed Bowl Efficiency</b>	72.77 %	<b>Thrust at Design</b>	826.9 lb
<b>Specific Gravity</b>	1.0000	<b>Best Efficiency</b>	76.70 %	<b>Thrust at Shut Off</b>	1106.2 lb
<b>Viscosity</b>	1.0017 cP	<b>BEP Flow</b>	111.0 USgpm	<b>Thrust at Run Out</b>	517.1 lb
<b>Vapor Pressure</b>	0.3393 psi	<b>Design Flow % BEP</b>	99.10 %	<b>Bowl Material</b>	Cast Iron with Glass Enamel
<b>Density</b>	62 lbs/ft <sup>3</sup>	<b>Pump Efficiency</b>	75.59 %	<b>Bowl Material Derate Factor</b>	1.00
<b>Design Flow</b>	110.0 USgpm	<b>Motor Efficiency</b>	92.40 %	<b>Impeller Material</b>	316SS
<b>Min Flow (MCSF)</b>	27.8 USgpm	<b>Overall Efficiency</b>	69.85 %	<b>Impeller Matl Derate Factor</b>	1.00
<b>Design TDH (Bowl)</b>	268.0 ft	<b>Friction Loss at Design</b>	0.14 ft	<b>Total Flow Derate Factor</b>	1.00
<b>Design TDH (Disch Flange)</b>	259.1 ft	<b>Power at Design</b>	9.7 Hp	<b>Total Head Derate Factor</b>	1.00
<b>Design Pressure (Bowl)</b>	116.0 psi	<b>Guaranteed Power</b>	10.5 Hp	<b>Total Efficiency Derate Factor</b>	1.00
<b>Design Pressure (Disch Flange)</b>	112.2 psi	<b>NOL Power</b>	10.1 Hp	<b>Total Derate Factor</b>	1.00
<b>Shut Off TDH (Bowl)</b>	369.0 ft	<b>Max Power (NOL) Flow</b>	135.0 USgpm	<b>Total Efficiency Derate Factor</b>	1.00

**CERTIFIED SUBMITTAL – REV1**

Certified By	BHAVIN KHARVA	10/03/2023
Project	OP-556186 Thornton Irrigation PS	
Tag	2301328 OP	
PO Number	2328010	
Serial Number	5113518 – REV1	

# NIDEC MOTOR CORPORATION

8050 WEST FLORISSANT AVE.  
ST. LOUIS, MO 63136



DATE: 1/14/2020

P.O. NO.: FU28  
Order/Line NO.: 25773 MN 100

TO:

Model Number: FU28  
Catalog Number: CHT15V2BLE  
VHS TEFC Configuration  
CONF,MOTOR,VHS TEFC

REVISIONS:  
(NONE)

**ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.  
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.**

## Features:

Horsepower ..... 00015.00~00000.00 ~ KW: 11.19  
Enclosure ..... TEFC  
Poles ..... 04~00 ~ RPM: 1800~0  
Frame Size ..... 254~TP  
Phase/Frequency/Voltage.. 3~060~230/460  
Winding Type ..... Random Wound  
Service Factor ..... 1.15  
Insulation Class ..... Class "H" ~ Insulife 2000  
Altitude In Feet (Max) .. 3300 Ft.(1000 M) ~ +40 C  
Efficiency Class ..... Premium Efficiency  
Application ..... Vertical Centrifugal Pump  
Inverter Duty NEMA MG1 Part 31  
Customer Part Number ....  
10" Base ~ Coupling Size: 1" Bore, 1/4" Key  
Non-Reverse Ratchet ~ Steady Bushing Not Requested  
Pricebook Thrust Value (lbs).. 3300  
Customer Down Thrust (lbs) ... 3300  
Customer Shutoff Thrust (lbs).  
Up Thrust (lbs): ~  
Inverter Duty Rating Details:  
Load Type (Base Hz & Below) .. Variable Torque  
Speed Range (Base Hz & Below). 10:1  
Temperature Rise (Sine Wave): "B" Rise @ 1.0 SF (Resist)  
Starting Method ..... PWS (Dual Volt-Low Volt Only)  
Duty Cycle ..... Continuous Duty  
Efficiency Value ..... 92.4 % ~ Typical  
Load Inertia: NEMA ~ Standard Inertia: 75 LB-FT2  
Number Of Starts Per Hour: NEMA  
Motor Type Code ..... TUCI  
Rotor Inertia (LB-FT<sup>2</sup>) ..... 2.18 LB-FT<sup>2</sup>  
Qty. of Bearings PE (Shaft) ..... 1  
Qty. of Bearings SE (OPP) ..... 1  
Bearing Number PE (Shaft) ..... 7310 BEP  
Bearing Number SE (OPP) ..... 6210-J/C3

Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.



# NIDEC MOTOR CORPORATION

8050 WEST FLORISSANT AVE.  
ST. LOUIS, MO 63136



DATE: 1/14/2020

P.O. NO.: FU28  
Order/Line NO.: 25773 MN 100

TO:

Model Number: FU28  
Catalog Number: CHT15V2BLE  
VHS TEFC Configuration  
CONF,MOTOR,VHS TEFC

REVISIONS:  
(NONE)

**ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.  
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.**

## Accessories:

Shaft Slinger - Pulley End  
Corro-Duty  
CCW Rot. FODE w/Rotation Arrow  
Ground Lug In Conduit Box  
Aegis Grd Ring/Grd Term on Frm  
115 Volt Space Heaters  
Special Balance  
Thermostats - Normally Closed  
Conduit Box Information: ~ Std. Oversized- Std. Const.  
Conduit Opening Size (AA) .. 1.5" NPT  
1 Conduit Opening ~ Bottom Of Conduit Box  
MIN 500 RPM WITH NRR  
Standard Leadtime: NA  
Est. Weight (lbs ea): 395 ~ F.O.B.:

**USE THE DATA PROVIDED BELOW TO SELECT THE APPROPRIATE DIMENSION PRINT**

<b>Horsepower</b>	15
<b>Pole(s)</b>	04
<b>Voltage(s)</b>	460-230
<b>Frame Size</b>	254TP
<b>Outlet Box AF</b>	2.63
<b>Outlet Box AA</b>	1.5

Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.

EFFECTIVE:  
**26-APR-18**

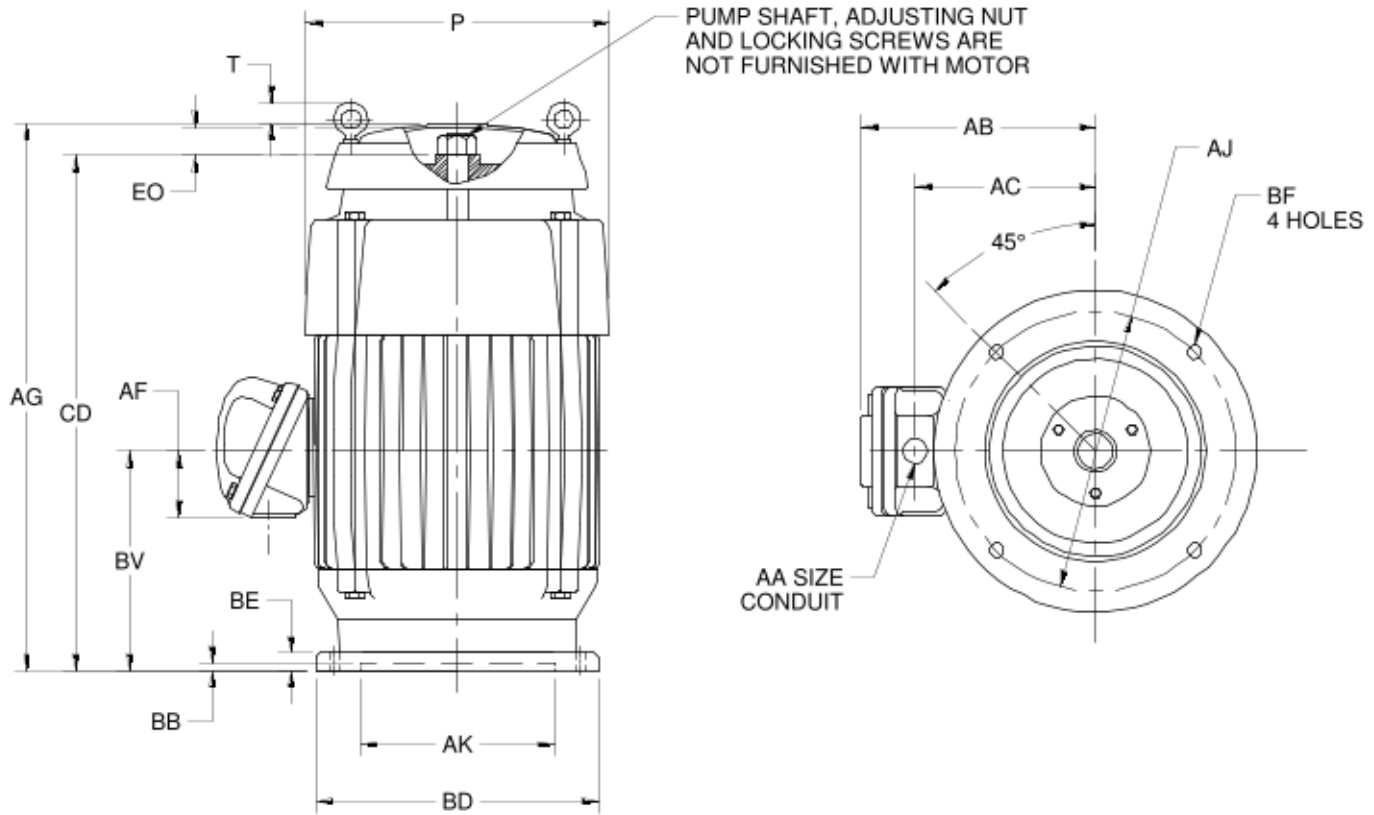
**DIMENSION PRINT**  
TEFC

PRINT:  
**09-3339**

SUPERSEDES:  
**NEW**

FRAME: 250TP, TPH  
BASIC TYPE: TUCI

SHEET:  
**1 OF 1**



ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS

UNITS	P <sup>2</sup>	T <sup>4</sup>	AA	AB	AC	AF	AG	AJ	AK +.003	BB MIN	BE	BF
IN	13.81	-1.00	1-1/2 NPT	11.53	8.53	2.63	28.63	9.125	8.250	.19	.59	.44
MM	351	-25		293	217	67	727	231.78	209.55	5	15	11

UNITS	BV	CD	EO
IN	10.00	22.94	5.50
MM	254	583	140

FRAME	UNITS	BD MAX
254, 256TP	IN	10.00
	MM	254
254, 256TPH	IN	12.00
	MM	305

- ALL ROUGH DIMENSIONS MAY VARY BY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
- LARGEST MOTOR WIDTH.
- CONDUIT OPENINGS MAY BE LOCATED IN STEPS OF 90 DEGREES REGARDLESS OF LOCATION. STANDARD AS SHOWN WITH CONDUIT OPENING DOWN.
- (-) MINUS SIGN INDICATES EYEBOLTS ARE BELOW THE TOP OF UNIT.
- TOLERANCES SHOWN ARE IN INCHES ONLY.

TOLERANCES	8.500 AK
FACE RUNOUT	.004 T.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBIT	.004 T.I.R.
PERMISSIBLE SHAFT RUNOUT	.002 T.I.R.

**Nidec Motor Corporation**  
St. Louis, Missouri

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ISSUED BY  
**R. LOPEZ**  
APPROVED BY  
**G. GARCIA**

# NAMEPLATE DATA

<p>CATALOG NUMBER: <input type="text" value="CHT15V2BLE"/></p> <p>MODEL <input type="text" value="FU28"/> <input type="text" value="FR"/> <input type="text" value="254TP"/></p> <p>SHAFT END BRG <input type="text" value="7310 BEP - QTY 1"/></p> <p>PH <input type="text" value="3"/> MAX AMB <input type="text" value="40 C"/></p> <p>INSUL CLASS <input type="text" value="H"/> Asm. Pos. <input type="text"/></p> <p>HP <input type="text" value="15"/> <input type="text"/> RPM <input type="text" value="1775"/> <input type="text"/></p> <p>VOLTS <input type="text" value="460"/> <input type="text" value="230"/> <input type="text"/></p> <p>FL AMPS <input type="text" value="17.8"/> <input type="text" value="36.0"/> <input type="text"/></p> <p>SF AMPS <input type="text" value="20.4"/> <input type="text" value="41.0"/> <input type="text"/></p> <p>SF <input type="text" value="1.15"/> DESIGN <input type="text" value="B"/> CODE <input type="text" value="G"/></p> <p>NEMA NOM EFFICIENCY <input type="text" value="92.4"/> NOM PF <input type="text" value="85.6"/> KiloWatt <input type="text" value="11.19"/></p> <p>GUARANTEED EFFICIENCY <input type="text" value="91.0"/> MAX KVAR <input type="text"/> HZ <input type="text" value="60"/></p>	<p>NAMEPLATE PART #: <input type="text" value="422707-005"/></p> <p>TYPE <input type="text" value="TUCI"/> ENCL <input type="text" value="TEFC"/></p> <p>OPP END BRG <input type="text" value="6210-J/C3 - QTY 1"/></p> <p>ID# <input type="text"/></p> <p>DUTY <input type="text" value="CONT"/></p> <p>HP <input type="text"/> <input type="text"/> RPM <input type="text"/> <input type="text"/></p> <p>VOLTS <input type="text"/> <input type="text"/> <input type="text"/></p> <p>FL AMPS <input type="text"/> <input type="text"/> <input type="text"/></p> <p>SF AMPS <input type="text"/> <input type="text"/> <input type="text"/></p> <p>SF <input type="text"/> DESIGN <input type="text"/> CODE <input type="text"/></p> <p>NEMA NOM EFFICIENCY <input type="text"/> NOM PF <input type="text"/></p> <p>GUARANTEED EFFICIENCY <input type="text"/> MAX KVAR <input type="text"/> HZ <input type="text"/></p>
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**HAZARDOUS LOCATION DATA (IF APPLICABLE):**

DIVISION <input type="text"/>	CLASS I <input type="text"/>	GROUP I <input type="text"/>
TEMP CODE <input type="text"/>	CLASS II <input type="text"/>	GROUP II <input type="text"/>

**VFD DATA (IF APPLICABLE):**

VOLTS	<input type="text" value="460"/>	<input type="text" value="230"/>
AMPS	<input type="text" value="18.7"/>	<input type="text" value="37.8"/>
TORQUE 1	<input type="text" value="44.3LB-FT"/>	
VFD LOAD TYPE 1	<input type="text" value="VT/PWM"/>	
VFD HERTZ RANGE 1	<input type="text" value="6-60"/>	
VFD SPEED RANGE 1	<input type="text" value="180-1800"/>	
SERVICE FACTOR	<input type="text" value="1.00"/>	
NO. POLES	<input type="text"/>	
VECTOR MAX RPM	<input type="text"/>	
Radians / Seconds	<input type="text"/>	



TORQUE 2	<input type="text"/>
VFD LOAD TYPE 2	<input type="text"/>
VFD HERTZ RANGE 2	<input type="text"/>
VFD SPEED RANGE 2	<input type="text"/>
FL SLIP	<input type="text"/>
MAGNETIZING AMPS	<input type="text"/>
Encoder PPR	<input type="text"/>
Encoder Volts	<input type="text"/>

**TEAO DATA (IF APPLICABLE):**

HP (AIR OVER) <input type="text"/>	HP (AIR OVER M/S) <input type="text"/>	RPM (AIR OVER) <input type="text"/>	RPM (AIR OVER M/S) <input type="text"/>
FPM AIR VELOCITY <input type="text"/>	FPM AIR VELOCITY M/S <input type="text"/>	FPM AIR VELOCITY SEC <input type="text"/>	

**ADDITIONAL NAMEPLATE DATA:**

Decal / Plate	WD=159833,CP=132839	Customer PN	
Notes		Non Rev Ratchet	NRR
Max Temp Rise	80C RISE/RES@1.00SF	OPP/Upper Oil Cap	GREASE
Thermal (WDG)	OVER TEMP PROT 2	SHAFT/Lower Oil Cap	GREASE
Altitude		Usable At	
Regulatory Notes		Regulatory Compliance	
COS		Marine Duty	
Balance	0.08 IN/SEC	Arctic Duty	
3/4 Load Eff.	92.8	Inrush Limit	
Motor Weight (LBS)	395	Direction of Rotation	
Sound Level		Special Note 1	
Vertical Thrust (LBS)	3300	Special Note 2	
Thrust Percentage	100% HT	Special Note 3	
Bearing Life		Special Note 4	
Starting Method		Special Note 5	
Number of Starts		Special Note 6	
200/208V 60Hz Max Amps		SH Max. Temp.	
190V 50 hz Max Amps		SH Voltage	SH VOLTS=115V
380V 50 Hz Max Amps		SH Watts	SH WATTS= 48W
NEMA Inertia		Load Inertia	
Sumpheater Voltage		Sumpheater Wattage	
Special Accessory Note 1		Special Accessory Note 16	
Special Accessory Note 2		Special Accessory Note 17	
Special Accessory Note 3		Special Accessory Note 18	
Special Accessory Note 4		Special Accessory Note 19	
Special Accessory Note 5		Special Accessory Note 20	
Special Accessory Note 6		Special Accessory Note 21	
Special Accessory Note 7		Special Accessory Note 22	
Special Accessory Note 8		Special Accessory Note 23	
Special Accessory Note 9		Special Accessory Note 24	
Special Accessory Note 10		Special Accessory Note 25	
Special Accessory Note 11		Special Accessory Note 26	
Special Accessory Note 12		Special Accessory Note 27	
Special Accessory Note 13		Special Accessory Note 28	
Special Accessory Note 14		Special Accessory Note 29	
Special Accessory Note 15		Special Accessory Note 30	MIN 500 RPM WITH NRR
Heater in C/B Voltage		Heater in C/B Watts	
Zone 2 Group		Division 2 Service Factor	
Note 1		Note 2	
Note 3			

**NIDEC MOTOR CORPORATION  
ST. LOUIS, MO**



TYPICAL NAMEPLATE DATA  
ACTUAL MOTOR NAMEPLATE LAYOUT MAY VARY  
SOME FIELDS MAY BE OMITTED

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## MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
FU28	CHT15V2BLE	3	TUCI	254TP
ORDER NO.		25773	LINE NO.	
MPI:			245958	245959
HP:			15	15
POLES:			4	4
VOLTS:			460	230
HZ:			60	60
SERVICE FACTOR:			1.15	1.15
EFFICIENCY (%):				
S.F.			92.3	92.3
FULL			92.4	92.4
3/4			92.8	92.8
1/2			91.7	91.7
1/4			86.8	86.8
POWER FACTOR (%):				
S.F.			85.9	85.9
FULL			85.6	85.6
3/4			83.2	83.2
1/2			76.5	76.5
1/4			58.1	58.1
NO LOAD			8.6	8.6
LOCKED ROTOR			44.7	44.7
AMPS:				
S.F.			20.4	41
FULL			17.8	36
3/4			13.6	27.3
1/2			10	20
1/4			7	13.9
NO LOAD			5.5	11
LOCKED ROTOR			117	235
NEMA CODE LETTER			G	G
NEMA DESIGN LETTER			B	B
FULL LOAD RPM			1775	1775
NEMA NOMINAL / EFFICIENCY (%)			92.4	92.4
GUARANTEED EFFICIENCY (%)			91	91
MAX KVAR			3.7	3.7
AMBIENT (°C)			40	40
ALTITUDE (FASL)			3300	3300
SAFE STALL TIME-HOT (SEC)			30	30
SOUND PRESSURE (DBA @ 1M)			0	0
TORQUES:				
BREAKDOWN{% F.L.}			258	258
LOCKED ROTOR{% F.L.}			252	252
FULL LOAD{LB-FT}			44.3	44.3

NEMA Nominal and Guaranteed Efficiencies are up to 3,300 feet above sea level and 25 ° C ambient

The Above Data Is Typical, Sinewave Power Unless Noted Otherwise

**NIDEC MOTOR CORPORATION**  
ST. LOUIS, MO

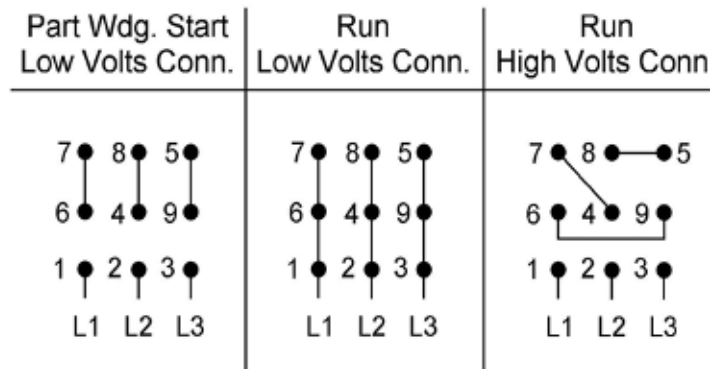




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**Motor Wiring Diagram**

9 Lead, Dual Voltage, Delta Connection  
Part Winding Start (PWS) on Low Voltage



Motor good for across the line starting

Per NEMA MG1 1998-1.75, "A Part-winding Start motor is one which certain specially designed circuits of each phase of the primary winding are initially connected to the supply line. The remaining circuit or circuits of each phase are connected to the supply in parallel with initially connected circuits, at a predetermined point in the starting operation." This is intended to limit the inrush current required to start the motor. NEMA MG1 1998-14.38 states that the motor may not accelerate to full speed in part-winding and may be noisier than when on full winding.

Motors designed by US Motors for Part-winding Start also be used for across the line starting using only the full winding connection. Damage will occur if the motor is operated with load for more than 2 seconds on Part-winding without transition to full winding.

To reverse direction of rotation, interchange leads L1 & L2.

Each lead may have one or more cables comprising that lead. In such case, each cable will be marked with the appropriate lead number.





**159833**

## **SPECIAL INFORMATION REGARDING PART WINDING STARTING**

This motor is not designed to fully accelerate when started with the part winding start connection shown on the motor connection diagram. In order to avoid damaging the motor when it is started with the part winding start connection, set timers so that the motor starter switches the motor connection from start to run within two seconds from the time that the motor is initially energized. The motor is not expected to fully accelerate before the motor connection is switched to run, but the momentary operation on the start connection should allow time for automatic voltage regulators on the power system to compensate for voltage dip resulting from the high current draw of the motor during acceleration. Thus, voltage dip in the power system will be minimized through proper use of the part winding start connection. Once the motor has been switched over to the run connection, it will finish accelerating up to full speed.

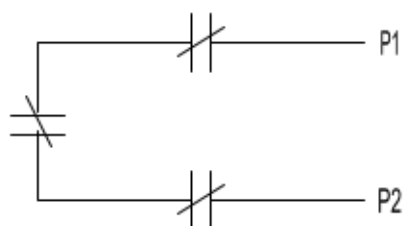
During the time that the motor is operated on the part winding start connection, it is expected that the motor may be noisier than when operated on the run connection and it is also expected that the line amp unbalance between phases may be approximately 100% to 150%. This is due to the adverse effect of harmonics that result from the unbalanced magnetic circuit on the part winding start connection.

For further information regarding characteristics of polyphase induction motors when operated on a part winding start connection, refer to NEMA Publication MG 1-1998 Part 14.38.

## THERMOSTATS

1. MOTOR IS EQUIPPED WITH QTY-3 (1 PER PHASE) NORMALLY CLOSED THERMOSTATS. THERMOSTATS ARE SET TO OPEN AT HIGH TEMPERATURE.
2. CONTACT RATINGS FOR THERMOSTATS: 120-600 VAC, 720 VA

N. C. THERMOSTATS



NOTE: THERMOSTATS LEADS MAY BE LOCATED IN EITHER THE MAIN OUTLET BOX OR IF SO EQUIPPED, AN AUXILIARY BOX.

### ACCESSORY LISTING

QTY-3 N.C. THERMOSTATS

REVISION DESCRIPTION FOR: <b>MISC</b>	SCALE	UNITS	TITLE		<b>NIDEC MOTOR CORPORATION</b>
<b>STL0211 - UPDATED FORMAT .</b>	<b>NONE</b>	<b>IN</b>	<b>CUSTOMER CONNECTION DIAGRAM</b>		
	TOLERANCES ON DIMENSIONS (UNLESS OTHERWISE SPECIFIED)		ISSUED BY	APPROVED BY	REVISION DATE
MATERIAL:	<u>INCHES</u>	<u>mm</u>	<b>R. KING</b>	<b>C. CADE</b>	<b>24-FEB-11</b>
	ANGLES $X^{\circ} = \pm 1^{\circ}$		CODE	DWG NO.	REV
				<b>0834066</b>	<b>G</b>
					SHEET NUMBER
					<b>1 OF 1</b>
					DWG SIZE
					<b>A</b>

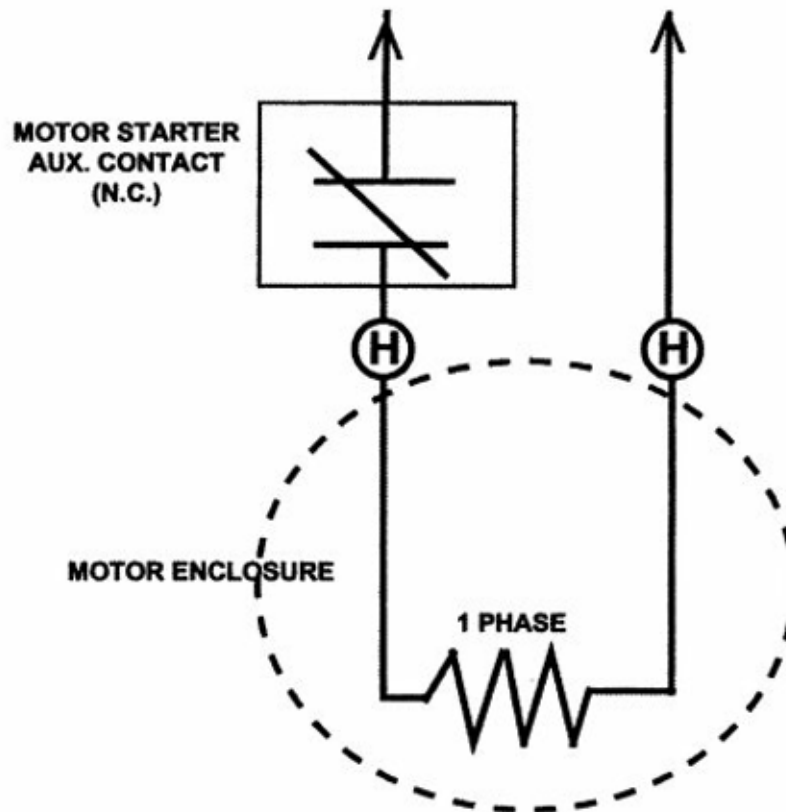




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# SPACE HEATER CONNECTION DIAGRAM

SPACE HEATER LEADS MAY BE LOCATED IN EITHER THE MAIN OUTLET BOX  
OR IF SO EQUIPPED, AN AUXILIARY BOX



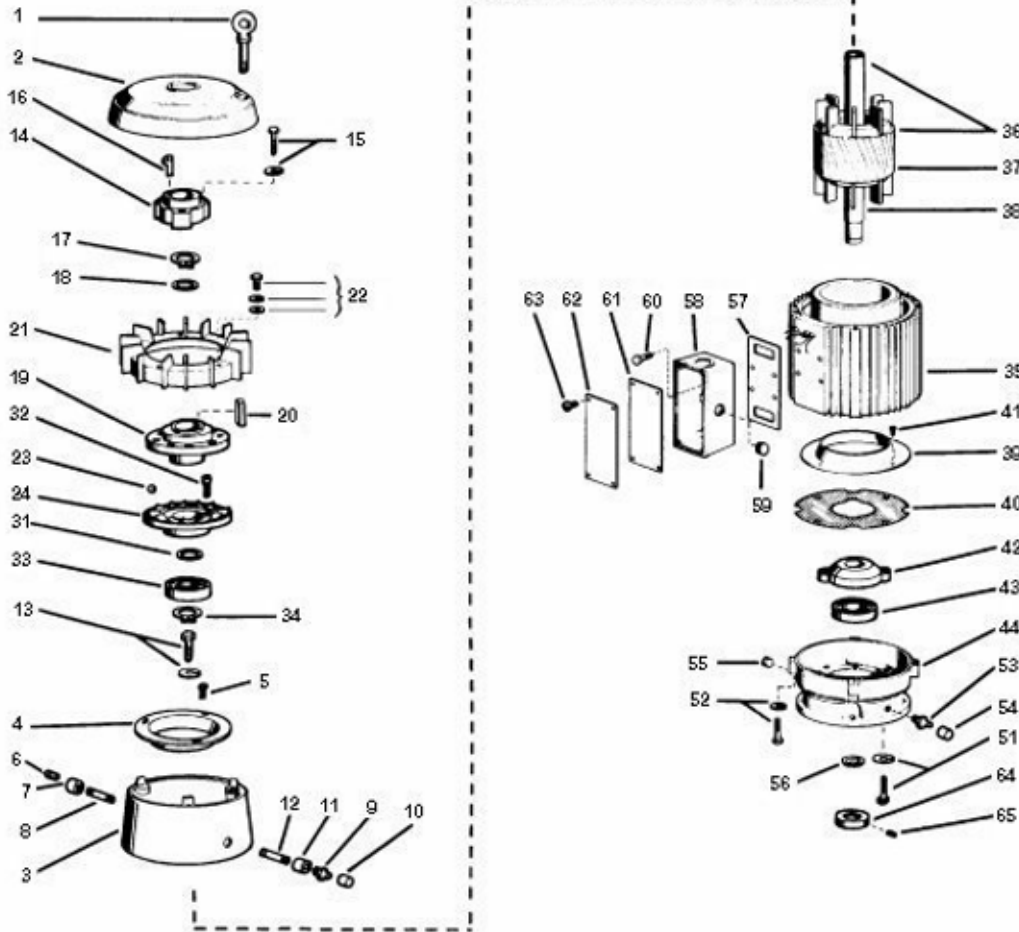
THIS EQUIPMENT IS SUPPLIED WITH ANTI-CONDENSATION HEATERS. HEATERS SHOULD BE ENERGIZED WHEN EQUIPMENT IS NOT OPERATING TO PROTECT UNIT BY PREVENTING INTERNAL CONDENSATION. CONNECT THE "H" OR HEATER LEADS TO

<b>115V</b> VOLTS	<b>48W</b> WATTS RATING
-------------------	-------------------------

**SPACE HEATER NAMEPLATE (ON MOTOR)**

## RENEWAL PARTS

FRAMES 182 THRU 215 - OPEN DRIPPROOF  
 FRAMES 182 THRU 286 - TOTALLY ENCLOSED  
 TYPES: AU, AUE, AUI, JU, LU, LUCS, LUS, TU, TUC, TUCI, TUCS, TUE, TUI, TUS  
 HIGH THRUST HOLLOSHAFT MOTORS



ITEM NO.	QTY	NAME OF PART
1	2	Eyebolt
2	1	Canopy Cap
3	1	Upper Bracket
4	1	Air Deflector (Upper)
5	3	Screw (Air Deflector)
6	1	Pipe Plug
7	1	Pipe Coupling
8	1	Nipple Fitting
9	1	Grease Fitting
10	1	Plastic Cap

**WARNING:**

Any disassembly or repair work on explosionproof motors will void the Underwriters Laboratories, Inc. label unless done by the manufacturer, or a facility approved by the Underwriters Laboratories, Inc. Refer to your nearest sales office for assistance.

**BEARINGS:**

Refer to motor nameplate for the bearing numbers.

**PRICES:**

Parts stocking distributors: refer to renewal parts numerical index. All Others: refer to your nearest parts distributor.

## RENEWAL PARTS

FRAMES 182 THRU 215 - OPEN DRIPPROOF  
FRAMES 182 THRU 286 - TOTALLY ENCLOSED  
TYPES: AU, AUE, AUI, JU, LU, LUCS, LUS, TU, TUC, TUCI, TUCS, TUE, TUI, TUS

### HIGH THRUST HOLLOSHAFT MOTORS

ITEM NO.	QTY	NAME OF PART
11	1	Pipe Coupling
12	1	Nipple Fitting
13	4	Screw & Lockwasher (Bracket to Stator)
14	1	Drive Coupling
15	3	Screw & Lockwasher (Drive Coupling)
16	1	Gib Key
17	1	Snap Ring
18	As Req	Shims
19	1	Rotating Ratchet
20	1	Square Key
21	1	Fan
22	5	Screw, Washer & Lockwasher (Fan to Ratchet)
23	10	Steel Ball
24	1	Stationary Ratchet
25-30	-	NOT USED THIS ASSEMBLY
31	As Req	Shims
32	3	Screw (Stationary Ratchet)
33	1	Ball Bearing (Upper) (Refer to Section 775)
34	1	Snap Ring
35	1	Wound Stator Assembly
36	1	Rotor Assembly (Includes Items 37 & 38)
37	1	Rotor Core
38	1	Rotor Shaft

ITEM NO.	QTY	NAME OF PART
39	1	Air Deflector (Lower)
40	1	Bracket Screen (AU Only)
41	4	Screw (Air Deflector)
42	1	Bearing Cap (Lower)
43	1	Ball Bearing (Lower) (Refer to Section 775)
44	1	Lower Bracket
45-50	-	NOT USED THIS ASSEMBLY
51	2	Screw & Lockwasher (Bearing Cap)
52	4	Screw & Lockwasher (Bracket to Stator)
53	1	Grease Fitting
54	1	Plastic Cap (Not Illustrated)
55	1	Pipe Plug
56	1	Water Deflector
57	1	Gasket (Outlet Box Base)
58	1	Outlet Box Base
59	1	Pipe Plug
60	4	Screw
61	1	Gasket (Outlet Box Cover)
62	1	Outlet Box Cover
63	4	Screw
64*	1	Stabilizer Bushing (Optional)
65*	2	Screw (Optional)

\* With optional Stabilizer Bushing, delete Item No. 56 and add Items 64 & 65

**WARNING:**

Any disassembly or repair work on explosionproof motors will void the Underwriters Laboratories, Inc. label unless done by the manufacturer, or a facility approved by the Underwriters Laboratories, Inc. Refer to your nearest sales office for assistance.

**BEARINGS:**

Refer to motor nameplate for the bearing numbers.

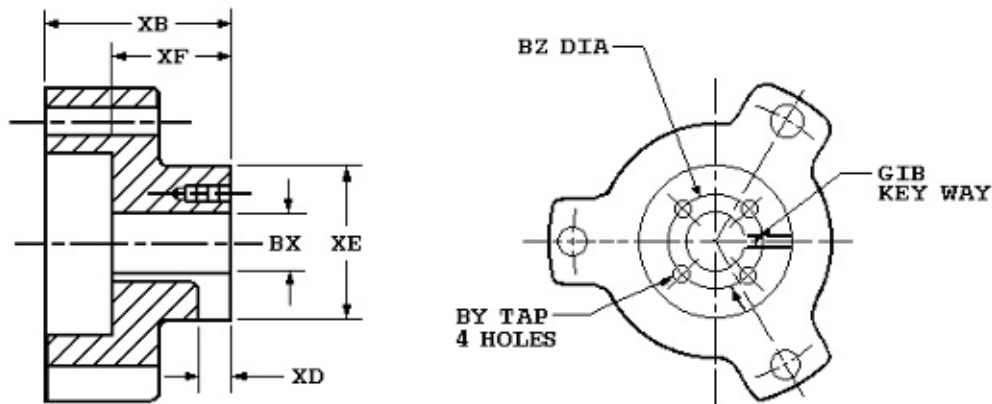
**PRICES:**

Parts stocking distributors: refer to renewal parts numerical index. All Others: refer to your nearest parts distributor.

reference: Renewal Parts Section 700, Pages 145 & 146

# Vertical HOLLOSHAFT Coupling Dimensions

## Standard Coupling Dimensions



Coupling Part Number	102999
BX Nominal	1
Actual Bore	1.001
BY	10-32
BZ	1 3/8
XB	2 9/16
XD	13/32
XE	2 1/4
XF	1 5/8
SQ. KEY	1/4

### Notes:

1. All Rough casting dimensions may vary by 0.25" due to casting variations.
2. All tapped holes are Unified National Course, Right Hand thread.
3. Coupling bore dimension "BX" is machined with a tolerance of - .000", +.001" up to 1.50" bore inclusive. Larger bores: -.000", +.002".



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## TYPICAL REED CRITICAL FREQUENCY DATA

Note: Motor RCF Test Data can be provided at time of motor shipment through special test.  
Please contact your Nidec Motor Corporation representative for more information.

MODEL NO: FU28  
CATALOG NO: CHT15V2BLE

Frame: 254TP Type: TUCI

REED CRITICAL FREQUENCY:	98	HZ
CENTER OF GRAVITY:	10	IN
DEFLECTION @ CENTER OF GRAVITY:	0.001	IN
UNIT WEIGHT:	350	LBS
BASE DIAMETER:	ALL	IN
TOLERANCE ON RCF VALUE:	20%	
DATE:	1/14/2020	



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# General Information for Integral Horsepower (IHP) Motors on Variable Frequency Drives (VFDs)

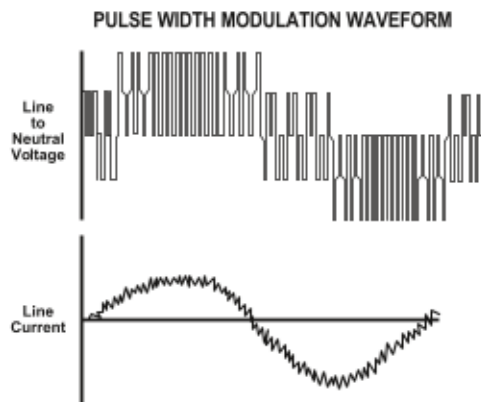
## Variable Frequency Drives (VFD)

A VFD is a type of controller used to vary the speed of an electric motor. The VFD takes a fixed AC voltage and frequency and allows it to be adjusted in order to get different speeds from the motor. Motor speed can be varied by changing the frequency of the input power waveform. The equation below shows how the frequency affects the speed of a three phase induction motor.

$$\text{Speed} = \frac{120 * \text{Fundamental Input Frequency}}{\text{Number of Motor Poles}}$$

## How does a VFD work?

A VFD takes the fixed frequency and voltage sine wave from the power grid or power station and puts it through a few steps in order to allow the VFD user to vary the frequency and in turn control the motor speed. First it rectifies the AC power into DC Power. Because of this step, a term commonly used instead of VFD is inverter. This only describes one step of what the VFD does to the power waveform. Once rectified into a DC voltage the drive sends the power through a set of transistors or switches. These switches can take the DC waveform and by opening and closing at certain speeds and durations can create an output waveform that mimics the sine wave that is required to drive a three phase electric motor. The output wave form is known as a Pulse Width Modulation (PWM) waveform because the waveform is created by multiple pulses of the switches at short intervals.



## What variables should be considered when deciding whether to power a motor with a VFD?

VFD compatibility with motors is complex. As a result, many variables must be considered when determining the suitability of a particular motor for use with a VFD. These variables include:

- Torque requirements (Constant or Variable)
- Speed Range
- Line / System Voltage
- Cable length between the VFD and the motor
- Drive switching (carrier) frequency
- Motor construction

- VFD dv/dt - winding end turn differential in voltage versus differential in time
- High temperatures or high humidity
- Grounding system

Wider speed ranges, higher voltages, higher switching frequencies, insufficient grounding and increased cable lengths all add to the severity of the application and, therefore, the potential for premature motor failure.

## How does a VFD affect the motor?

There are many things to consider when a motor is powered using a VFD or PWM power. When a motor is powered by a PWM waveform the motor windings very often see a large differential voltage, either from phase to phase or turn to turn. When the voltage differential becomes large enough it creates a reaction at the molecular level that converts available oxygen into O<sub>3</sub>. This phenomenon is called partial discharge or corona. This reaction creates energy in the form of light and heat. This energy has a corrosive effect on the varnish used to protect the motor windings. PWM waveforms can also magnify shaft voltages which lead to arcing across the bearing and causing premature bearing failure. Corrective action must be taken to mitigate these issues that arise when using an electric motor with a VFD.

## How do I protect the motor?

Nidec Motor Corporation (NMC) has developed specific motor designs to decrease the harmful affects that a VFD can have on a motor. NMC's INVERTER GRADE<sup>®</sup> insulation system is the first line of defense against corona and phase to phase faults that can be common when a motor is powered using a PWM waveform. The INVERTER GRADE<sup>®</sup> insulation system is standard on all of NMC's Inverter Duty products. Along with the INVERTER GRADE<sup>®</sup> insulation, thermostats are installed as a minimum protection against over heating the motor. Special consideration must also be given to bearings in motors powered by VFD's. In order to create a low resistance path to ground for built up shaft voltages a shaft grounding device can be used. On larger horsepower motors an insulated bearing system should be used in conjunction with the shaft grounding device when installed, to force the stray shaft voltages to ground. The bearing failures are more prominent on motors with thrust handling bearings. NMC has created an Inverter Duty vertical motor line that not only uses the INVERTER GRADE<sup>®</sup> insulation system, but that also comes standard with a shaft grounding device. On motors that are 100 HP and greater the thrust bearing is also insulated for additional protection.

## What does "Inverter Duty" mean?

An Inverter Duty motor should describe a motor that helps mitigate potential failure modes of a motor that is powered by a VFD. Inverter duty motor windings should be able to withstand the voltage spikes per NEMA MG1 Part 31.4.4.2 and protect against overheating when the motor is run at slow speeds. On thrust handling bearings it is apparent that the bearings require additional protection. Inverter Duty vertical motors should have a shaft grounding device to protect the motor bearings from fluting due to voltage discharge through the bearing. On larger motors (100HP and larger) the shaft should also be electrically isolated from the frame in order to aid the shaft grounding ring in discharging the shaft voltages to ground.

\*This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL<sup>®</sup> & CSA<sup>®</sup> listings where indicated.

## Motor / Inverter Compatibility

---

### Thermal Overloads and Single Phase Motors

Motors with thermal overloads installed may not operate properly on a VFD. The current carrying thermal overload is designed for sine wave power. Operation on a VFD may cause nuisance tripping or potentially not protect the motor as would be expected on line power. Thermostats or thermistors installed in the motor and connected properly to the VFD may provide suitable thermal overload protection when operating on a VFD. (consult codes for installation requirements)

Single phase motors and other fractional horsepower ratings are not designed to be operated on a VFD. Within Nidec Motor Corporation standard products, all motors NEMA<sup>®</sup> 48 frame (5.5" diameter) and smaller are not suitable for VFD applications. Three phase 56 and 143/145 frame applications should be noted on the catalog price page; or if in doubt ask an Nidec Motor Corporation technical representative for recommendations on compatibility with a VFD.

### Slow Speed Motors

Motors with a base design of slower than six poles require special consideration regarding VFD sizing and minimizing harmonic distortion created at the motor terminals due to cable installation characteristics. Additional external PWM waveform filters and shielded motor cables designed for PWM power may be required to provide acceptable motor life. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%) mismatch impedance.

### 690V Applications

Motors that are rated for 690VAC and that will be powered by 690VAC PWM VFDs require the use of an external filter to limit peak voltage spikes and the use of an INVERTER GRADE<sup>®</sup> motor. Where available, an alternative to using an output filter is to upgrade to a 2300V insulation system.

### Low Voltage TITAN<sup>®</sup> Motors

When using 449 frame and larger motors on PWM type VFDs consider the use of an external filter and shielded motor cables designed for PWM power to minimize harmonic distortion and peak voltages at the motor terminals. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%).

### Bearing Currents Related to PWM Waveforms

Protection of the motor bearings from shaft currents caused by common mode voltages is becoming a standard feature on Inverter Duty motor products. Some installations may be prone to a voltage discharge condition through the motor bearings called Electrical Discharge Machining (EDM) or fluting. Vertical HOLLOSHAFT and HOSTILE DUTY World Motor come with grounding devices installed as standard. EDM damage is related to characteristics of the PWM waveform, and the VFD programming, and installations factors.

### Bearing Protection on Inverter Duty Vertical Motors

All U.S. MOTORS<sup>®</sup> brand "Inverter Duty" vertical products have a shaft grounding system that allows damaging shaft currents a low resistance path to ground. **Bearings on vertical motors fed by VFD power without this bearing protection are not covered under any warranty.** All other bearing failure is covered per NMC's standard warranty. An electric motor repair shop approved to service U.S. MOTORS<sup>®</sup> brand motors must verify that the cause of the bearing failure was not due to EDM damage.

### Multiple Motors on a Single VFD

Special considerations are required when multiple motors are powered from a single VFD unit. Most VFD manufacturers can provide guidelines for proper motor thermal considerations and starting/stopping of motors. Cable runs from the VFD and each motor can create conditions that will cause extra stress on the motor winding. Filters may be required at the motor to provide maximum motor life.

### Grounding and Cable Installation Guidelines

Proper output winding and grounding practices can be instrumental in minimizing motor related failures caused by PWM waveform characteristics and installation factors. VFD manufacturers typically provide detailed guidelines on the proper grounding of the motor to the VFD and output cable routing. Cabling manufacturers provide recommended cable types for PWM installations and critical information concerning output wiring impedance and capacitance to ground.

### Vertical Motors on VFDs

Vertical motors operated on VFD power present unique conditions that may require consideration by the user or installation engineer:

- Locked rotor and drive tripping caused by non-reversing-ratchet operation at low motor speeds. It is not recommended to operate motors at less than 1/4 of synchronous speed. If slow speeds are required contact NMC engineering.
- Unexpected / unacceptable system vibration and or noise levels caused by the torque pulsation characteristics of the PWM waveform, a system critical frequency falling inside the variable speed range of the process or the added harmonic content of the PWM waveform exciting a system component
- Application related problems related to the controlled acceleration/ deceleration and torque of the motor on VFD power and the building of system pressure/ load.
- The impact the reduction of pump speed has on the down thrust reflected to the pump motor and any minimum thrust requirements of the motor bearings
- Water hammer during shutdown damaging the non-reversing ratchet

### Humidity and Non-operational Conditions

The possible build-up of condensation inside the motor due to storage in an uncontrolled environment or non-operational periods in an installation, can lead to an increased rate of premature winding or bearing failures when combined with the stresses associated with PWM waveform characteristics. Moisture and condensation in and on the motor winding over time can provide tracking paths to ground, lower the resistance of the motor winding to ground, and lower the Corona Inception Voltage (CIV) level of the winding.

Proper storage and maintenance guidelines are important to minimize the potential of premature failures. Space heaters or trickle voltage heating methods are the common methods for drying out a winding that has low resistance readings. **Damage caused by these factors are not covered by the limited warranty provided for the motor unless appropriate heating methods are properly utilized during non-operational periods and prior to motor start-up.**

NEMA<sup>®</sup> Application Guide for AC Adjustable Speed Drive Systems:  
<http://www.nema.org/stds/acadjustable.cfm#download>

\* This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL<sup>®</sup> & CSA<sup>®</sup> listings where indicated.



# Warranty Guidelines for Integral Horsepower (IHP)\* Motors on Variable Frequency Drives

## Warranty Guidelines

The information in the following section refers to the motor and drive application guidelines and limitations for warranty.

### Hazardous Location Motors

Use of a variable frequency drive with the motors in this catalog, intended for use in hazardous locations, is only approved for Division 1, Class I, Group D hazardous location motors with a T2B temperature code, with a limitation of 2:1 constant torque or 10:1 variable torque output. **No other stock hazardous location motors are inherently suitable for operation with a variable frequency drive.** If other requirements are needed, including non-listed Division 2, please contact your Nidec Motor Corporation territory manager to conduct an engineering inquiry.

### 575 Volt Motors

575 volt motors can be applied on Inverters when output filters are used. Contact the drive manufacturer for filter selection and installation requirements.

### Applying INVERTER GRADE® Insulated Motors on Variable Frequency Drives (2, 4, 6 pole)

The products within this catalog labeled "Inverter Duty" or "Vector Duty" are considered INVERTER GRADE® insulated motors. INVERTER GRADE® motors exceed the NEMA® MG-1 Part 31 standard. Nidec Motor Corporation provides a three-year limited warranty on all NEMA® frame INVERTER GRADE® insulated motors and allows long cable runs between the motor and the VFD (limited to 400 feet without output filters). Cable distance can be further limited by hot and humid environments and VFD manufacturers cable limits. These motors may be appropriate for certain severe inverter applications or when the factors relating to the end use application are undefined (such as spares).

Nidec Motor Corporation's U.S. Motors® brand is available in the following INVERTER GRADE® insulated motors:

- Inverter Duty NEMA® frame motors good for 20:1 Variable Torque & 5:1 Constant Torque, including Vertical Type RUSI (10:1 V.T.)
- Inverter Duty motors rated for 20:1 Constant Torque
- ACCU-Torq® and Vector Duty Motors with full torque to 0 Speed or 5000:1
- 841 Plus® NEMA® Frame Motors

### Applying Premium Efficient motors (that do not have INVERTER GRADE® insulation) on Variable Frequency Drives (2, 4, 6 pole)

Premium efficient motors without INVERTER GRADE insulation meet minimum NEMA® MG-1, Section IV, Part 31.4.4.2. These motors can be used with Variable Frequency Drives (with a reduced warranty period) under the following parameters:

- On NEMA® frame 447 and smaller motors, 20:1 speed rating on variable torque loads & 4:1 speed range on constant torque loads.
- On TITAN® 449 and larger frame motors, 10:1 speed rating on variable torque loads.

- On TITAN® frame motors, inquiry required for suitability on constant torque loads.

Cable distances are for reference only and can be further limited by hot and humid environments (refer to Table 1). Refer to specific VFD

Table 1 - Cable Distances			
Maximum Cable Distance VFD to Motor			
Switching Frequency	460 Volt	230 Volt	380 Volt
3 KHz	127 ft	400 ft	218 ft
6 KHz	90 ft	307 ft	154 ft
9 KHz	73 ft	251 ft	126 ft
12 KHz	64 ft	217 ft	109 ft
15 KHz	57 ft	194 ft	98 ft
20 KHz	49 ft	168 ft	85 ft

manufacturers cable limits. Refer to the Motor/ Inverter Compatibility page for special consideration of vertical motor bearings.

## Warranty Period Clarifications and Exceptions

### Standard Energy Efficient Exclusion

Applying Standard & Energy Efficient Motors on Variable Frequency Drives is not recommended. VFD related failures on standard and energy efficient motors will not be covered under warranty.

### Vertical Motor Windings

Premium efficient vertical motors without INVERTER GRADE® insulation that are installed using the criteria described in this document and applied in the correct applications shall have a warranty while powered by a VFD for 12 months from date of installation or 18 months from date of manufacturing whichever comes first. See limited warranty page for horizontal motor warranty periods.

### Bearing Exclusion for Thrust Handling Bearings

Bearings used in premium efficient vertical motors, and all thrust handling bearings, that are powered by VFDs without shaft grounding devices or insulated bearings (when required) will not be covered under any warranty for damages caused from being powered by a VFD. All other bearing failure is covered per NMC's standard warranty. An electric motor repair shop approved to service U.S. MOTORS® brand motors must verify that the cause of the bearing failure was not due to Electrical Discharge Machining.

### Medium Voltage and Slow Speed Considerations

Motors that are rated above 700 VAC or that are eight pole and slower require special consideration and installation and are not covered under the warranty guidelines in this document. Motors that are rated above 700VAC have special cable length and voltage differential issues that are specific to the VFD type and manufacture. The motor construction and cost may vary dramatically depending on the VFD topology and construction. Contact your NMC representative with VFD manufacturer name and model type for application and motor construction considerations. Motors that are designed eight pole and slower also require special installation and filters per the drive manufacturer.

\* This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL® & CSA® listings where indicated.