

**UNITED STATES OF AMERICA  
BEFORE THE  
FEDERAL ENERGY REGULATORY COMMISSION**

**Klamath River Renewal Corporation  
PacifiCorp**

**Project Nos. 14803-001;  
2082-063**

**AMENDED APPLICATION FOR SURRENDER OF LICENSE  
FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS**

**EXHIBIT R  
100% Design Report  
(Part 9 of 12)**

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**EXHIBIT R-5  
Fall Creek Hatchery  
(continued)**

## **Fall Creek Hatchery 100% Design Specifications**



# Klamath River Renewal Project

## Fall Creek Fish Hatchery— Technical Specifications IFC Design Submittal

**FINAL**  
**Revision No. 00**



October 2020



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The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seals, as professional engineers/architects licensed to practice as such, are affixed on the following pages



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October 28, 2020

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October 28, 2020

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**FALL CREEK FISH HATCHERY DESIGN  
TECHNICAL SPECIFICATIONS**

**100% DESIGN  
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## **SECTION 01 11 00 - SUMMARY OF WORK**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The WORK to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

#### **1.2 WORK COVERED BY CONTRACT DOCUMENTS**

- A. The WORK of this Contract comprises the construction of the following:
  - 1. A concrete intake structure on the southeast bank of Fall Creek adjacent to Dam A. The intake will divert up to 10 cfs from Fall Creek.
  - 2. A concrete apron downstream of Dam A to create a velocity fish barrier to preclude adult and juvenile fish.
  - 3. A concrete apron downstream of Dam B to create a velocity fish barrier to preclude adult and juvenile fish.
  - 4. A pre-engineered metal building (PEMB) Coho building to house Coho incubation, grow-out and rearing raceway infrastructure. Rehabilitate existing upper raceway structure concrete.
  - 5. Concrete Chinook Raceways that include fish screen guide slots and stop log slots along the length of the structure such that ponding volumes can be incremented based on fish development.
  - 6. PEMB Chinook Incubation building to house the chinook egg incubation operations.
  - 7. PEMB spawning building.
  - 8. Rehabilitate and construct new concrete walls in existing lower raceways to create the adult holding ponds.
  - 9. A Denil-type fish ladder.
  - 10. A concrete sill for installation of a temporary fish exclusion barrier during spawning operations.
  - 11. An earthen fish barrier berm to prevent fish passage during extreme flood events.



12. Portions of the WORK involve the installation of equipment and materials to be furnished by the OWNER.

B. The WORK is located at the existing Fall Creek Fish Hatchery site located in Siskiyou County northwest of Iron Gate Dam near Yreka, California.

### 1.3 CONTRACT METHOD

A. The WORK hereunder will be constructed under a single lump sum contract.

### 1.4 CONTRACTOR USE OF SITE

A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, and on-Site fabrication facilities.

### 1.5 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing operating pipeline, tank, valve, channel, equipment, structure, road, or any other facility without permission from the ENGINEER.

B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of two (2) weeks in advance of the time that such outage is planned.

C. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

D. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

### 1.6 PROJECT MEETINGS

#### A. **Preconstruction Conference**

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:

a. ENGINEER and the Resident Project Representative.

b. Representatives of OWNER.

c. Governmental representatives as appropriate.

d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.

2. The CONTRACTOR shall bring the preconstruction conference submittals in accordance with Section 01 33 00 - Contractor Submittals.
3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.
  - a. Status of CONTRACTOR's insurance and bonds.
  - b. CONTRACTOR's tentative schedules.
  - c. Transmittal, review, and distribution of CONTRACTOR's submittals.
  - d. Processing applications for payment.
  - e. Maintaining record documents.
  - f. Critical work sequencing.
  - g. Detailed outage plan.
  - h. Field decisions and Change Orders.
  - i. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
  - j. Major equipment deliveries and priorities.
  - k. CONTRACTOR's assignments for safety and first aid.
  - l. Daily Report Form which the ENGINEER will furnish.
  - m. Submittal Transmittal Form which the ENGINEER will furnish.
4. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.
5. The CONTRACTOR and its subcontractors should plan on the conference taking no less than two (2) full working days. The first day will cover the items listed in paragraphs 2 and 3, and the following day(s) will be spent on reviewing the Drawings and Specifications, in extensive detail, with the ENGINEER and the OWNER.

#### **B. Progress Meetings**

1. The ENGINEER will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by CONTRACTOR or as required by progress of the WORK. The CONTRACTOR, ENGINEER, and all subcontractors active on the Site shall attend each meeting. CONTRACTOR may at its discretion

request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The ENGINEER will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the WORK, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## **SECTION 01 12 00 - HYDROLOGY AND HYDRAULICS**

### **PART 1 -- GENERAL**

#### **1.1 OVERVIEW**

- A. This Section describes: the hydrologic data at the site and the typical operations of the Fall Creek powerhouse and City of Yreka intake structures.
- B. This Section is provided for information only and does not guarantee specific hydrology or hydraulics.

#### **1.2 FALL CREEK POWERHOUSE OPERATIONS**

- A. The Fall Creek Powerhouse is located approximately 0.8 miles upstream from the mouth of Fall Creek at Iron Gate Reservoir and directly upstream from the Project site. PacifiCorp operates a set of dams and canals on Spring Creek and Fall Creek to divert a maximum of 50 cubic feet per second (cfs) to the powerhouse. The powerhouse discharges to a constructed tailrace canal that discharges to Fall Creek at the north end of the Project site.
- B. The current license for the Fall Creek powerhouse requires that 15 cfs or the natural stream flow (whichever is less) be maintained downstream of the powerhouse.

#### **1.3 DEFINITIONS**

- A. In-Water Work (IWW): Work that is performed within the limits of the Ordinary High Water Mark (OHWM), as defined on the Contract Drawings. This definition does not imply that work outside of the OHWM will not be impacted by extreme events. Some areas not designated IWW are within the channel floodplain.

#### **1.4 CITY OF YREKA INTAKE OPERATIONS**

- A. The City of Yreka maintains two diversions that supply the City's drinking water: (1) Dam A and (2) Dam B.
  - 1. Dam A is located on the powerhouse tailrace canal and has a typical crest elevation of 2510.4 feet (Vertical Datum NAVD88, Geoid 12B). There exists on Dam A a flashboard spillway with invert elevation 2507.4 ft (NAVD88), and a sluice gate at elevation 2506.0 ft (NAVD88). Adjacent to Dam A, on the west bank of the tailrace canal, is located the City of Yreka intake structure, which consists of a set of screens and a 24" diameter water main (invert elevation 2505.15 ft NAVD88) that conveys water to the City of Yreka.
  - 2. Dam B is located on Fall Creek, approximately 300 ft upstream of the confluence with the powerhouse canal and the Project site. Dam B has a crest elevation of 2513.4 ft (NAVD88) and has two (2) x five-foot-wide flashboard slots. The intake structure is located on the south bank of the creek and consists of a set of screens and a 24" diameter conveyance pipe (invert elevation 2506.9 ft NAVD88) that

conveys water across the creek to the Dam A impoundment, adjacent to the Dam A intake.

- B. The City of Yreka maintains a 15 cfs consumptive water right. If flows are insufficient in the powerhouse canal, the Dam B intake is operated to convey make-up flows from Fall Creek to the Dam A impoundment, where water is then diverted to the City.

#### 1.5 AREAS FOR IN-WATER WORK (IWW)

- A. There exist five locations as part of the Work defined for this Project for which IWW is expected:
  - 1. Dam A – Work in the powerhouse canal is expected at and around Dam A for the construction of the hatchery intake, and for the construction of the velocity barrier modifications to Dam A.
  - 2. Dam B – Work in Fall Creek is expected at Dam B for the construction of the velocity barrier modifications to Dam B.
  - 3. Existing Flume Demolition – Work in the powerhouse canal is expected at the existing concrete flume for demolition and backfill work.
  - 4. Chinook Fish Release Pool – Work in Fall Creek is expected for installation of the fish release pipe, and construction and earthworks associated with the outlet pool. This will be located as indicated on the Contract Drawings.
  - 5. Fish Barrier and Fishway – Work in Fall Creek is expected for the construction of the fish barrier and fishway and appurtenant earthworks and concrete construction. This will be located at the downstream limits of the Project.

#### 1.6 COFFERDAM AND DESIGN WATER LEVELS DURING CONSTRUCTION

- A. The cofferdam design shall be per Specification Section 02 15 00 – Cofferdam and Protective Works.
- B. CONTRACTOR shall take into account the below design and overflow levels in planning and scheduling construction activities. Provisions for all cofferdams shall be CONTRACTOR's responsibility.

#### 1.7 PROJECT HYDROLOGY RECORDS

- A. The U.S. Geological Survey (USGS) maintained a stream monitoring gage (USGS Gage No. 11512000) located on Fall Creek approximately 2/3 miles downstream from the Project site. The data record associated with this gage extends from 1933 to 1959, and from 2003 to 2005. This is the best available stream flow information for the site.
- B. Table 01 12 00 – 01 presents a summary of the maximum, 5%, 50%, 95% exceedance, and minimum flows per month and annually. The low flow period is from May to November. The high flow period is from December to April. January and February typically see the highest flows, and August sees the lowest flows.

**Table 01 12 00 – 01. Flow Summary**

Flow (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Minimum	28	27	29	28	25	24	23	21	22	27	26	28	21
95% Exceedance	28	30	33	30	28	27	25	25	25	28	29	29	27
50% Exceedance	41	44	48	43	36	33	32	31	33	34	37	38	36
5% Exceedance	82	93	81	69	55	49	45	46	46	48	54	69	63
1% Exceedance	165	142	92	85	62	57	50	47	47	52	62	150	92
Maximum	249	200	130	187	65	58	52	47	52	77	137	474	474

C. The 15 largest floods of record are listed in Table 01 12 00 – 02.

**Table 01 12 00 – 02. Flood of Records, 1933 – 1959 and 2003 - 2005**

Date	Peak Flow (cfs)
12/22/1955	474
1/15/1956	249
12/21/1955	247
1/10/1936	245
12/23/1955	244
1/28/1958	219
1/29/1958	219
12/27/1942	213
12/11/1937	200
2/21/1956	200
1/4/1946	198
1/7/1948	193
1/18/1953	188
4/13/1937	187
1/2/1936	178

- D. The 100-year flow at the USGS gage station was collected from the USGS based on the 28-year gage data. The 100-year flow at the USGS gage station, approximately 2/3 miles downstream of the Project site is 905 cfs.
- E. The ordinary high-water mark (OHWM) is defined as the point on a stream bank at which the presence and action of surface water is so continuous as to leave a distinct erosion mark, destruction or prevention of woody terrestrial vegetation, predominance of aquatic vegetation, or other easily recognized characteristics. Therefore, the OHWM defines the jurisdictional boundary between upland and riparian areas subject to permitting requirements. The OHWM is often defined as the 2-year flood elevation. To obtain the 2-year flood elevation, the USGS defined 2-year flood was collected for the USGS gage 11512000. The 2-year recurrence interval peak flow is about 138 cfs. This can be used to determine the OHWM at the various locations of IWW.

## 1.8 WATER SURFACE ELEVATIONS

- A. Water surface elevations as depicted in the Contract Drawings are for reference with regards to fish passage characteristics and design flood events. They do not represent monthly or annual exceedance probabilities but are defined based on fish passage requirements. The CONTRACTOR should not use the water surface elevations or flow rates as depicted in the Contract Drawings, but rather the information presented in this Specification, for reference.
- B. Water surface elevations at the locations of IWW will be impacted by the CONTRACTOR's use of cofferdam systems, protective works, dewatering and bypass infrastructure, and construction staging. Therefore, predictions of design water surface levels cannot be accurately made prior to the development of cofferdam and dewatering plans, and it shall be incumbent upon the CONTRACTOR to perform calculations and make determinations regarding the design water surface levels during construction. Hydrologic data has been provided to aid the CONTRACTOR in making such determinations.

## 1.9 AREA WEATHER

- A. Precipitation and Temperature records were collected from the nearby NOAA station in Montague, CA at the Siskiyou Airport, and are provided below for the CONTRACTOR's reference.
- B. Precipitation varies throughout the year with the highest average monthly precipitation during November and the lowest during August. The average rainfall in the Montague, CA for each month is listed in Table 01 12 00 – 05.

**Table 01 12 00 – 05. Average Precipitation and Temperature Records**

Month	Precipitation (inches)	Temperature (°F)	
		High	Low
January	2.2	45	26
February	2.0	51	28
March	2.3	56	30
April	1.6	61	33
May	1.4	72	40
June	0.7	80	47
July	0.5	91	54
August	0.3	90	52
September	0.6	81	43
October	1.2	68	36
November	3.0	50	29
December	2.7	44	26

- C. Temperature and other weather conditions at the site vary throughout the year and should be carefully factored into the construction work. CONTRACTOR shall comply with all applicable cold weather construction practices and requirements.

#### 1.10 CONSTRUCTION LIMITATION

- A. Construction activities must not impede the City of Yreka obtaining its full water right of 15 cfs throughout the entire construction period.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### 3.1 CONSTRUCTION PLANNING AND SCHEDULING

- A. CONTRACTOR shall take account the above described hydrology, hydraulic design, and weather conditions when planning and scheduling all construction activities. CONTRACTOR shall ensure the work is carried out in a safe manner, protected from damage, and in accordance with standard accepted construction practice.

- END OF SECTION -



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## **SECTION 01 29 00 - SCHEDULE OF VALUES**

### **PART 1 -- GENERAL**

#### **1.1 GENERAL**

- A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the cost loading function of the CPM Schedule per Section 01 32 15 – CPM Construction Schedule. Monthly progress payment amounts shall be determined from the monthly progress updates of the CPM Schedule activities.
- B. The Schedule of Values shall be developed independent but simultaneous with the development of the CPM Schedule activities and logic.

#### **1.2 PRELIMINARY SCHEDULE OF VALUES**

- A. The CONTRACTOR shall submit a preliminary Schedule of Values for the major components of the WORK at the Preconstruction Conference in accordance with Section 01 11 00 - Summary of Work. The listing shall include, at a minimum, the proposed value for the following major WORK components:

- 1. Mobilization
- 2. The total value of electrical WORK.
- 3. The total value of Instrumentation and Control WORK.
- 4. The total value of Protective Coatings WORK.
- 5. The total value of yard mechanical WORK inclusive of excavation, pipe installation, testing and backfill of pipe, and all incidental WORK associated with underground pipe installations.
- 6. The total value of mechanical WORK, exclusive of yard mechanical WORK included in Item 5 above. This includes piping, valves, equipment, tanks, and appurtenances at new and existing structures. Additionally, this total value shall be broken down into separate values for each new and existing structure constructed or modified as a part of the WORK.
- 7. The total value of structural reinforced concrete WORK inclusive of excavation, dewatering, subgrade preparation, backfill and incidental WORK for new structures. Additionally, this total value shall be broken down into separate values for each new structure constructed as a part of the WORK. Miscellaneous and minor concrete WORK may be listed as one item in this breakdown.
- 8. The total value of pre-engineered metal buildings, inclusive of architectural WORK, doors, windows and other incidental systems and features. Additionally, this total value shall be broken down into separate values for each pre-engineered metal building.

9. The total value of site civil WORK inclusive of clearing and grubbing, paving, grading and drainage WORK.

10. The total value of other WORK not specifically included in the above items.

- B. The CONTRACTOR and ENGINEER shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the ENGINEER, these are necessary to establish fair and reasonable allocation of values for the major WORK components. Front end loading will not be permitted. The ENGINEER may require reallocation of major WORK components from items in the above listing if in the opinion of the ENGINEER such reallocation is necessary. This review and any necessary revisions shall be completed within 15 Days from the date of Notice to Proceed.

### 1.3 DETAILED SCHEDULE OF VALUES

- A. The CONTRACTOR shall prepare and submit a detailed Schedule of Values to the ENGINEER within 30 Days from the date of Notice to Proceed. The detailed Schedule of Values shall be based on the accepted preliminary Schedule of Values for major WORK components. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM Schedule activities, sufficient detailed breakdown shall be provided to meet this requirement. The ENGINEER shall be the sole judge of acceptable numbers, details and description of values established. If, in the opinion of the ENGINEER, a greater number of Schedule of Values items than proposed by the CONTRACTOR is necessary, the CONTRACTOR shall add the additional items so identified by the ENGINEER.

1. The minimum detail of breakdown of the major WORK components is indicated below. Greater detail shall be provided if requested by the ENGINEER.

- a. Mobilization - no breakdown required.
- b. Section 01 32 15 - CPM Construction Schedule, broken down by submittal.
- c. The electrical WORK shall be broken down by structure and yard facilities. Structures electrical WORK shall be broken down into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations and lighting. Yard facilities shall be broken down by duct bank designation and substations.
- d. Instrumentation and Control WORK shall be broken down by structure.
- e. Protective Coating WORK shall be broken down by structure and yard area. Where specific coating WORK at structures or yard areas may be critical to performing the WORK to meet milestone and Contract Times, such WORK shall be included as individual pay and Schedule activity items.
- f. Yard piping WORK shall be broken down into individual pipelines running from and to Contract termination points. Each pipeline shall be an individual pay item unless otherwise allowed by the ENGINEER.

- g. Mechanical WORK shall be broken down within each structure to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.
  - h. Concrete structures shall be broken down into excavation, subgrade preparation, and appurtenant prefoundation WORK, concrete foundation construction, slabs on grade, walls/columns, suspended slabs, stairs, etc. (sufficient breakdown shall be provided to accommodate necessary Schedule detail), hydrostatic structure testing where required and backfill.
  - i. Pre-engineered metal buildings shall be broken down into building frame erection, roofs, decks, siding and soffit WORK, insulation, doors/windows/louvers, and any other items determined to be necessary for establishment of pay and Schedule activity items.
  - j. Civil site WORK shall be broken down into individual drainage piping, drainage structures, site concrete, paving, excavation cut and fill, removal of existing pipe, clearing and grubbing and any other items determined to be necessary for the establishment of Pay and Schedule Activity items.
  - k. Pre-commissioning and commissioning broken down for completion milestones for each.
  - l. Other WORK not specifically included in the above items shall be broken down as necessary for establishment of pay and Schedule activity items.
2. The CONTRACTOR and ENGINEER shall meet and jointly review the detailed Schedule of Values within 35 Days from the date of Notice to Proceed. The value allocations and extent of detail shall be reviewed to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed to allow acceptable cost loading of the CPM Schedule activities. Any adjustments deemed necessary to the value allocation or level of detail shall be made by the CONTRACTOR and a revised detailed Schedule of Values shall be submitted within 40 Days from the date of Notice to Proceed.
3. Following acceptance of the detailed Schedule of Values, the CONTRACTOR shall incorporate the values into the cost loading portion of the CPM Schedule. The CPM activities and logic shall have been developed concurrent with development of the detailed Schedule of Values; however, it shall be necessary to adjust the detailed Schedule of Values to correlate to individual Schedule activities. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the CPM Schedule activities, where interfacing these 2 documents will require changes to each document. Schedule activities may need to be added to accommodate the detail of the Schedule of Values. Schedule of Value items may need to be added to accommodate the detail of the CPM Schedule activities. Where such instances arise, the CONTRACTOR shall propose changes to the Schedule of Values and to the CPM Schedule activities to satisfy the CPM Schedule cost loading requirements.

#### 1.4 CROSS REFERENCE LISTING

- A. To assist in the correlation of the Schedule of Values and the CPM Schedule, the CONTRACTOR shall provide a Cross Reference Listing which shall be furnished in 2 parts. The first part shall list each Scheduled Activity with the breakdown of the respective valued items making up the total cost of the activity. The second part shall list the valued item with the respective Scheduled Activity or Activities that make up the total cost indicated. In the case where a number of schedule items make up the total cost for a valued item (shown in the Schedule of Values) the total cost for each scheduled item should be indicated.
- B. These listings shall be updated and submitted in conjunction with the CPM monthly submittals as stated in Specification Section 01 32 15.
- C. Approved change orders reflected in the CPM Schedule shall be incorporated into the Schedule of Values as a single unit identified by the change order number.

#### 1.5 CHANGES TO SCHEDULE OF VALUES

- A. Changes to the CPM Schedule which add activities not included in the original schedule but included in the original WORK (schedule omissions) shall have values assigned as approved by the ENGINEER. Other activity values shall be reduced to provide equal value adjustment increases for added activities as approved by the ENGINEER.
- B. In the event that the CONTRACTOR and ENGINEER agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

#### 1.6 LIQUIDATED DAMAGES

- A. The Schedule of Values information is an integral part of the scheduling and reporting under Section 01 32 15 and the progress payment information. As such, it is critical information to evaluating progress and the proper planning of the OWNER's and ENGINEER's WORK-related effort as well as their financial obligations associated with this project. Accordingly, if any submittal required by this Section is found to be incomplete or is submitted later than required, the OWNER will suffer financial loss and, accordingly, liquidated damages will be assessed against the CONTRACTOR in accordance with Article 3 of the Agreement.

#### **PART 2 -- PRODUCTS (NOT USED)**

#### **PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## SECTION 01 32 15 - CPM CONSTRUCTION SCHEDULE

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. The CONTRACTOR shall schedule the WORK in accordance with this Section.
- B. Development of the schedule, monthly payment requisitions and project status reporting requirements of the Contract shall employ computerized Critical Path Method (CPM) scheduling.
- C. The CPM schedule and related reports should be prepared with the current version of **Primavera Project Planner**, or other project planning software as approved by Engineer.

#### 1.2 DEFINITIONS

- A. **CPM Scheduling:** The term shall be interpreted to be generally as outlined in the Association of General Contractors (AGC) publication, "The Use of CPM in Construction." except that either "i-j" arrow diagrams or precedence diagramming format may be utilized. In the case of conflicts between this Section and the AGC document, this Section shall govern.
- B. **Float:** Unless otherwise indicated herein, float and total float are synonymous. Total float is the period of time measured by the number of Days each non-critical path activity may be delayed before it and its succeeding activities become part of the critical path. If a non-critical path activity is delayed beyond its float period, then that activity becomes part of the critical path and controls the end date of the WORK. Thus, delay of a non-critical path activity beyond its float period will cause delay to the project itself.

#### 1.3 SCHEDULING QUALIFICATION SUBMITTALS

- A. CONTRACTOR shall submit a statement of computerized CPM capability within 10 Days after Notice to Proceed to verify that either: (1) the CONTRACTOR has in-house capability qualified to use CPM techniques and the **Primavera** or other project planning software or (2) that the CONTRACTOR will arrange for the services of a CPM consultant so qualified. In either event the statement shall identify the individual who will perform the CPM scheduling and shall describe the construction projects required below. The statement shall also identify the contact persons for the referenced projects with current telephone and address information.
- B. **Criteria:** The individual performing scheduling shall have successfully applied computerized CPM technique to at least two (2) projects of similar nature, scope, and value not less than one half the Total Bid Price of this project.

#### 1.4 INITIAL SCHEDULE SUBMITTALS

- A. Where submittals are required hereunder, the CONTRACTOR shall submit four (4) copies of each submittal item.

- B. The CONTRACTOR shall submit two (2) schedule documents at the Preconstruction Conference which serve as the CONTRACTOR's plan of operation for the initial 60 Day period of the Contract Times and identify the manner in which the CONTRACTOR intends to complete the WORK within the Contract Times.
1. 60 Day Plan of Operation: During the initial 60 Days of the Contract Times, the CONTRACTOR shall conduct operations in accordance with a 60 Day bar chart type schedule. The chart so prepared shall show accomplishment of the CONTRACTOR's early activities (mobilization, permit acquisition, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, CPM submittals, initial sitework and other submittals and activities required in the first 60 Days).
  2. Project Overview Bar Chart: The overview bar chart shall indicate the major components of the WORK and the sequence relations between major components and subdivisions of major components. The overview bar chart shall indicate the relationships and time frames in which the various components of the WORK will be made substantially complete and placed into service in order to meet the required milestones. Sufficient detail shall be included to subdivide major components in such activities as (1) excavation, (2) foundation subgrade preparation, (3) foundation concrete, (4) completion of structural concrete, (5) major mechanical WORK, (6) major electrical WORK, (7) instrumentation and control WORK, and (8) other important WORK for each major facility within the overall project scope. Planned durations and start dates shall be indicated for each WORK item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 36-inches by 60-inches in size. No more than 4 sheets shall be employed to present this overview information.
- C. The ENGINEER and the CONTRACTOR shall meet to review and discuss the 60 Day plan of operation and project overview bar chart within five (5) Days after submittal to the ENGINEER. The ENGINEER's review and comment on the schedules will be limited to conformance with the sequencing and milestone requirements in the Contract Documents. The CONTRACTOR shall make corrections to the schedules necessary to comply with the requirements and shall adjust the schedules to incorporate any missing information requested by the ENGINEER.

#### 1.5 CPM SCHEDULE SUBMITTALS

- A. **Original CPM Schedule Submittal:** Within 45 Days after the commencement date stated in the Notice to Proceed, the CONTRACTOR shall submit for review by the ENGINEER a hard copy of the CPM schedule and the computerized schedule report tabulations. The CONTRACTOR shall also submit a CD that contain the schedule submittal information. The data shall be compatible with **Primavera** or other project scheduling software to generate network diagrams and schedule reports identical to the hard copies submitted. This submittal shall have already been reviewed and approved by the CONTRACTOR's Project Manager, superintendent, and estimator prior to submission. The CPM schedule shall be a time-scaled network diagram of the "i-j" activity-on-arrow or precedence type. The network diagram shall describe the activities to be accomplished and their logical relationships and shall show the critical path.
- B. The computerized schedule report tabulations shall include the following:

1. Report of activities sorted by activity number: Activity numbers, where practical, shall correlate to the area numbers designated on the Contract Drawings as further defined in Section 01 11 00 - Summary of Work.
2. Report of activities sorted by early start date.
3. Report of activities sorted by total float.
4. Report of activities sorted by responsibility code. Responsibility codes shall be established for the CONTRACTOR, ENGINEER, OWNER, Subcontractors, Suppliers, etc. These codes shall be identified in the Network Diagram.
5. A successor-predecessor report which shall identify the successor and predecessor activities for each activity and ties between schedule activities.

**C. Analysis**

1. Early Completion
  - a. The CONTRACTOR may show early completion on the original CPM submittal if that is its plan.
  - b. An original CPM submittal showing early completion shall either be accompanied by:
    - 1) Request for change of Contract Times at zero change of Contract Price, accompanied by documentation demonstrating that the Bid was based on early completion, or
    - 2) Demonstration in the submittal that the time difference between early completion and the original Contract Time is total float.
  - c. An early completion schedule unaccompanied by one of these will not be accepted.
  - d. The ENGINEER will analyze a request for Change Order in accordance with the General Conditions.
2. Float Ownership: Neither the OWNER nor the CONTRACTOR owns the float time. The project owns the float time. Liability for delay to the project completion date rests with the party causing the delay. For example, if Party A is responsible for consuming a portion of the float time and Party B later consumes the remainder of the float time plus additional time beyond the float time, Party B is responsible for the time that is a delay past the completion date. Party A would not be responsible for any delay since it did not consume all the float time, additional float time remained after its delay, and the completion date was unaffected by its tardiness.

- D. Original CPM Schedule Review Meeting:** The CONTRACTOR shall, within 55 Days from the commencement date stated in the Notice to Proceed, meet with the ENGINEER to review the original CPM schedule submittal. The CONTRACTOR shall have the Project Manager, superintendent, and the scheduler in attendance. The meeting will



take place over a two (2) Day period. The ENGINEER's review will be limited to conformance with the Contract Documents. However, the review may also include:

1. Clarifications of the design intent.
2. Directions to include activities and information missing from the submittal.
3. Requests to the CONTRACTOR to clarify and revise the schedule.

E. **Revisions to the Original CPM Schedule:** Within 65 Days after the commencement date stated in the Notice to Proceed, the CONTRACTOR shall revise the original CPM schedule submittal to address review comments from the original CPM schedule review meeting and resubmit the network diagrams and reports for the ENGINEER's review. The ENGINEER, within 14 Days from the date that the CONTRACTOR submitted the revised schedule will either (1) accept the schedule as submitted, or (2) advise the CONTRACTOR in writing to review any part or parts of the schedule which either do not meet the requirements or are unsatisfactory for the ENGINEER to monitor the progress and status of WORK or evaluate monthly payment requests by the CONTRACTOR. The ENGINEER may accept the schedule conditional upon the first monthly CPM schedule update correcting deficiencies identified. When the schedule is accepted, it shall be considered as the "Original CPM Construction Schedule" until an updated schedule has been submitted. The ENGINEER reserves the right to require that the CONTRACTOR adjust, add to, or clarify any portion of the schedule which may later be discovered to be insufficient for the monitoring of WORK or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

F. **Acceptance**

1. Acceptance of the CONTRACTOR's schedule by the ENGINEER and OWNER will be based solely upon compliance with the requirements. By way of the CONTRACTOR assigning activity durations and proposing the sequence of the WORK, the CONTRACTOR agrees to utilize sufficient and necessary management and other resources to perform WORK in accordance with the schedule. Upon submittal of a schedule update, the updated schedule shall be considered the "current" project schedule.
2. Submission of the CONTRACTOR's progress schedule to the ENGINEER shall not relieve the CONTRACTOR of total responsibility for scheduling, sequencing, and pursuing the WORK to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed WORK.

G. **Monthly Updates and Periodic CPM Schedule Submittals**

1. Following acceptance of the CONTRACTOR's original CPM schedule, the CONTRACTOR shall monitor the progress of the WORK and adjust the schedule each month to reflect actual progress and any changes in planned future activities. Each schedule update submittal shall be complete including information requested in the original schedule submittal and be in the schedule report format indicated below. Each update shall continue to show WORK activities including those already

completed. Completed activities shall accurately depict "as built" information by indicating when the WORK was actually started and completed.

2. Neither the submission nor the updating of the CONTRACTOR's original schedule submittal nor the submission, updating, change, or revision of any other report, curve, schedule, or narrative submitted by the CONTRACTOR, nor the ENGINEER's review or acceptance of any such report, curve, schedule, or narrative shall have the effect of amending or modifying in any way the Contract Times or milestone dates or of modifying or limiting in any way the CONTRACTOR's obligations under the Contract. Only a signed, fully executed Change Order can modify contractual obligations.
3. The monthly schedule update submittal will be reviewed with the CONTRACTOR during a monthly construction progress meeting held on the 20th Day of each month. The goal of these meetings is to enable the CONTRACTOR and the ENGINEER to initiate appropriate remedial action to minimize any known or foreseen delay in completion of the WORK and to determine the amount of WORK completed since the last schedule update. The status of the WORK will be determined by the percent complete of each activity in the updated CPM schedule. These meetings are considered a critical component of the overall monthly schedule update submittal, and the CONTRACTOR shall have appropriate personnel attend. As a minimum, the CONTRACTOR's Project Manager and superintendent shall attend these meetings. The CONTRACTOR shall plan on the meeting taking no less than 6 hours. Within 7 Days after the monthly progress meeting, the CONTRACTOR shall submit the revised CPM schedule, the revised CPM computerized tabulations, the revised successor/predecessor report, the project status reports as defined below and the CONTRACTOR's Application for Payment. Within 5 Days of receipt of the revised submittals, the ENGINEER will either accept or reject the monthly schedule update submittal. If accepted, the percent complete in the monthly update shall be the basis for the Application for Payment to be submitted by the CONTRACTOR. If rejected, the update shall be corrected and resubmitted by the CONTRACTOR before the Application for Payment for the update period will be processed.

- H. **Schedule Revisions:** The CONTRACTOR shall highlight or otherwise identify changes to the schedule logic or activity durations made from the previous schedule. The CONTRACTOR shall modify any portions of the CPM schedule which become infeasible because activities are behind schedule or for any other valid reason.

## 1.6 CHANGE ORDERS

- A. Upon approval of a Change Order or upon receipt by the CONTRACTOR of authorization to proceed with additional WORK, the change shall be reflected in the next submittal of the CPM Schedule. The CONTRACTOR shall utilize a sub-network in the schedule depicting the changed WORK and its effect on other activities. This sub-network shall be tied to the main network with appropriate logic so that a true analysis of the critical path can be made. Whenever the CONTRACTOR believes that a Change Order will extend the Contract Times, the sub-network analysis herein shall be submitted with the price proposal for the change. If the CONTRACTOR does not submit the sub-network demonstrating that the change affects the Contract Times, then no subsequent claim for additional time due to the change will be accepted.

## 1.7 CPM STANDARDS

- A. **Construction Schedules:** Construction schedules shall include a graphic network diagram and computerized schedule reports as required below for status reporting.
- B. **Networks:** The CPM network shall be in a form of a time scaled "i-j" activity-on-arrow or precedence type diagram and may be divided into a number of separate sheets with suitable match lines relating the interface points among the sheets. Individual sheets shall not exceed 36-inches by 60-inches.
- C. Construction and procurement activities shall be presented in a time-scaled format with a calendar timeline along the entire sheet length. Each activity arrow or node shall be plotted so that the beginning and completion dates of each activity are accurately represented along the calendar timeline. Every activity shall use symbols that clearly distinguish between critical path activities, non-critical activities, and free float for each non-critical activity. Activity items shall be identified by their activity number, responsibility code, duration, and dollar value. Non-critical path activities shall show total float time in scale form by utilizing a dotted line or some other graphical means.
- D. **Duration Estimates:** The duration estimate for each activity shall be computed in Days and shall represent the single best estimate considering the scope of the WORK and resources planned for the activity. Except for certain non-labor activities such as curing of concrete or delivery of materials, activity duration shall not exceed 10 Days nor be less than one Day, unless otherwise accepted by the ENGINEER.

## 1.8 SCHEDULE REPORT FORMAT

- A. **Schedule Reports:** Schedule reports shall be prepared based on the CPM schedule, shall be submitted on paper and floppy disk or CD, depending on file size, and shall include the following minimum data for each activity:
  - 1. Activity numbers and responsibility codes.
  - 2. Work Order No.
  - 3. CIP No.
  - 4. Estimated activity duration.
  - 5. Activity description.
  - 6. Activity percent completion.
  - 7. Early start date (calendar dated).
  - 8. Early finish date (calendar dated).
  - 9. Late start date (calendar dated).
  - 10. Late finish date (calendar dated).
  - 11. Status (whether critical).

12. Total float for each activity.

13. Free float for each activity.

B. **Project Information:** Each Schedule Report shall be prefaced with the following summary data:

1. Project name.
2. CONTRACTOR name.
3. Type of tabulation.
4. Project duration.
5. Contract Times (as revised by Change Orders).
6. The commencement date stated in the Notice to Proceed.
7. The data date and plot date of the CPM Schedule.
8. If an update, cite the new schedule completion date.

#### 1.9 PROJECT STATUS REPORTING

- A. The CONTRACTOR shall furnish monthly project status reports (overview bar chart and a written narrative report) in conjunction with the revised CPM schedules as indicated above. Status reporting shall be in the form below.
- B. The CONTRACTOR shall prepare and submit monthly an overview bar chart schedule of the major project components. The overview bar chart schedule shall be a summary of the current CPM schedule (original and as updated and adjusted throughout the entire construction period). The major project components shall be represented as time bars which shall be subdivided into various types of WORK including demolition, excavation and earthwork, yard piping, concrete construction, and mechanical, electrical and instrumentation installations. Major components shall include each new structure by area designation, sitework, modifications to existing structures, tie-ins to existing facilities, and plant startups.
- C. Each major component and subdivision shall be accurately plotted consistent with the project overview bar chart above. It shall represent the same status indicated by early start and finish activity information contained in the latest update of the CPM schedule. In addition, a percent completion shall be indicated for each major component and subdivision. The initial submittal of the overview bar chart schedule shall be made at the time that the revised original CPM schedule is submitted to the ENGINEER. The CONTRACTOR shall amend the overview schedule to include any additional detail required by the ENGINEER. The CONTRACTOR shall include any additional information requested by the ENGINEER at any time during the construction of the WORK.

- D. The CONTRACTOR shall prepare monthly written narrative reports of the status of the project for submission to the ENGINEER. Status reports shall include:
1. The status of major project components (percent complete, amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.
  2. The progress made on critical activities indicated on the CPM schedule.
  3. Explanations for any lack of WORK on critical path activities planned for the last month.
  4. Explanations for any schedule changes, including changes to the logic and to activity durations.
  5. A list of the critical activities scheduled to be performed in the next 2 months.
  6. The status of major material and equipment procurement.
  7. The value of materials and equipment properly stored at the Site but not yet incorporated into the WORK.
  8. Any delays encountered during the reporting period.
  9. An assessment of inclement weather delays and impacts to the progress of the WORK.
- E. The CONTRACTOR may include any other information pertinent to the status of the WORK. The CONTRACTOR shall include additional status information requested by the ENGINEER.

#### 1.10 INCLEMENT WEATHER PROVISIONS OF THE SCHEDULE

- A. The CONTRACTOR's schedule shall include at least the number of Days of delay due to unusually severe weather as required by the Supplementary General Conditions.

#### 1.11 LIQUIDATED DAMAGES

- A. If any submittal required by this Section is determined by the ENGINEER to be incomplete or is submitted later than required, the OWNER will suffer financial loss, and accordingly, the CONTRACTOR shall pay liquidated damages in accordance the CONTRACTOR's agreement with the OWNER.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## **SECTION 01 33 00 - CONTRACTOR SUBMITTALS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. Wherever submittals are required in the Contract Documents, submit them to the OWNER or OWNER's Resident Representative as directed.
- B. Within seven (7) Days after the date of commencement as stated in the Notice to Proceed, the CONTRACTOR shall submit the following items for review:
  - 1. A preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("Or-Equal") submittals listed in the Bid. The schedule of submittals shall be based on CONTRACTOR's priority, planned construction sequence and schedule, long lead items, and size of submittal package. Allow time for resubmittals.
  - 2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

#### **1.2 PRECONSTRUCTION CONFERENCE SUBMITTALS**

- A. At the preconstruction conference of Section 01 11 00 - Summary of Work, the submit the following items to the OWNER for review:
  - 1. A revised schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals listed in the Bid.
  - 2. A list of permits and licenses the CONTRACTOR shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.
  - 3. A preliminary schedule of values in accordance with Section 01 29 00 - Schedule of Values.
  - 4. A 60-Day plan of operation in accordance with Section 01 32 15 - CPM Construction Schedule.

#### **1.3 SHOP DRAWINGS**

- A. All shop drawing submittals along with the shop drawing transmittal form, shall be made electronically in ".pdf" format and distributed by email from the CONTRACTOR to the OWNER's Resident Project Representative (RPR). The OWNER'S RPR shall be responsible to distribute each shop drawing to all reviewers and to receive and compile all review comments generated.
- B. Wherever called for in the Contract Documents or where required by the ENGINEER, the CONTRACTOR shall furnish a clear (non-scanned) electronic version, of each Shop Drawing submittal. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs,

catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the state wherein the project is located, unless otherwise indicated.

- C. Shop Drawing submittals shall be accompanied by the OWNER's standard submittal transmittal form, an electronic copy of which is available from the OWNER. A submittal without the form or where applicable items on the form are not completed will be returned for resubmittal.

**D. Organization**

1. A single submittal transmittal form shall be used for each technical specification section or item or class of material or equipment for which a submittal is required. A single submittal covering multiple sections will not be acceptable, unless the primary specification references other sections for components.
2. On the transmittal form, index the components of the submittal and insert tabs in the submittal to match the components. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.
3. Unless indicated otherwise, terminology and equipment names and numbers used in submittals shall match those used in the Contract Documents.

**E. Format**

1. Minimum sheet size shall be 8-1/2 inches by 11-inches. Maximum sheet size shall be 11-inches by 17-inches. Every page in a submittal shall be numbered in sequence. All sheets shall be submitted on one (1) pdf file and arranged.
2. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail shall be presented for assessment of compliance with the Contract Documents.
3. Each submittal shall be assigned a unique number. Submittals shall be numbered sequentially, and the submittal numbers shall be clearly noted on the transmittal. Original submittals shall be assigned a numeric submittal number followed by a decimal point and a "1" to indicate it is an original (first) submittal. (For example, if submittal number 16.1 requires a resubmittal, that resubmittal will bear the designation "16.2". A further resubmittal would bear the designation "16.3", etc.

- F. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.
- G. Except as may otherwise be indicated, the ENGINEER will return email comments (in pdf format) of each submittal to the OWNER's RPR with comments noted thereon, within 14 calendar Days following receipt by the ENGINEER. The OWNER's RPR will compile all comments and return the complete submittal (in pdf format), within 21 calendar days following original receipt by the OWNER's RPR. It is considered reasonable that the

CONTRACTOR will make a complete and acceptable submittal to the OWNER's RPR by the first resubmittal on an item. The OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the first resubmittal. The ENGINEER's and OWNER RPR's combined maximum review period for each submittal or resubmittal will be 21 calendar Days. Thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 63 calendar Days.

#### H. **Submittal Review Marking**

1. **NO EXCEPTIONS TAKEN.** If a submittal is returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.
  2. **MAKE CORRECTIONS NOTED.** If a submittal is returned marked "MAKE CORRECTIONS NOTED," CONTRACTOR shall make the corrections on the submittal, but formal revision and resubmission will not be required.
  3. **REVISE-RESUBMIT.** If a submittal is returned marked "REVISE-RESUBMIT," the CONTRACTOR shall revise it and shall resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing submittals will not be allowed. For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "REVISE - RESUBMIT," the submittal as a whole is deemed "REVISE - RESUBMIT," and all 10 drawings are required to be resubmitted.
  4. **REJECTED-RESUBMIT.** If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 - Products, Materials, Equipment, and Substitutions. In the first 2 cases, the CONTRACTOR shall prepare a new submittal and shall resubmit. In the latter case, the CONTRACTOR shall submit the substitution request according to Section 01 60 00.
- I. Resubmittal of rejected portions of a previous submittal will not be allowed. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.
- J. Fabrication of an item may commence only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.
- K. Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission to the ENGINEER. Each submittal shall be dated and signed by the CONTRACTOR as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, each sheet shall be so dated and signed. Any deviations from the Contract Documents shall be noted on the transmittal sheet. The ENGINEER will only review submittals that have been so verified by the CONTRACTOR. Non-verified submittals will be returned to the CONTRACTOR without



action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

- L. Corrections or comments made on the CONTRACTOR's Shop Drawings during review do not relieve the CONTRACTOR from compliance with Contract Drawings and Specifications. Review is for conformance to the design concept and general compliance with the Contract Documents only. The CONTRACTOR is responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating WORK with the trades, and satisfactory and safe performance of the WORK.

#### 1.4 SAMPLES

- A. The CONTRACTOR shall submit the number of samples indicated by the Specifications. If the number is not indicated, submit not less than three (3) samples. Where the amount of each sample is not indicated, submit such amount as necessary for proper examination and testing by the methods indicated.
- B. Samples shall be individually and indelibly labeled or tagged, indicating the salient physical characteristics and manufacturer's name. Upon acceptance by the ENGINEER, one set of the samples will be stamped and dated by the ENGINEER and returned to the CONTRACTOR, one set of samples will be retained by the OWNER, and one set shall remain at the Site in the OWNER RPR's field office until completion of the WORK.
- C. Unless indicated otherwise, the OWNER will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the CONTRACTOR shall clearly state so on the transmittal page of the submittal.
- D. The CONTRACTOR shall schedule color and texture sample submittals such that:
  - 1. Sample submittals for color and texture selection are complete so the OWNER or ENGINEER's Architect has 21 Days to assemble color panels and select color and texture dependent products and materials without delay to the construction schedule, and
  - 2. After the OWNER's or ENGINEER's Architect selects colors and textures, the CONTRACTOR has sufficient time to provide the products or materials without delay to the construction schedule. The Contract Times will not be extended for the CONTRACTOR's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

#### 1.5 TECHNICAL MANUAL

- A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual. It shall be written so that it can be used and understood by the OWNER's operation and maintenance staff.

- B. **Organization.** The Technical Manual shall be subdivided first by specification section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

1. **Category 1 - Equipment Summary**

- a. Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.
- b. Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

2. **Category 2 - Operational Procedures**

- a. Operational and Maintenance procedures shall be written in Microsoft <sup>TM</sup> Word document format for the startup, operation, maintenance, emergency situations and shutdown for all facility systems. The procedures shall be written in a step by step method for proper operation or maintenance of each individual system. For example, the startup procedure for a water supply to raceways system shall include operation of valves, gates, meters, HMI procedures, etc. to bring the system online and functioning properly.
- b. Manufacturer-recommended procedures on the following shall be included in Part 2:
  - 1) Installation
  - 2) Adjustment
  - 3) Startup
  - 4) Location of controls, special tools, equipment required, or related instrumentation needed for operation
  - 5) Operation procedures
  - 6) Load changes
  - 7) Calibration
  - 8) Shutdown
  - 9) Troubleshooting
  - 10) Disassembly
  - 11) Reassembly
  - 12) Realignment

- 13) Testing to determine performance efficiency
- 14) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices
- 15) List of all electrical relay settings including alarm and contact settings

**3. Category 3 - Preventive Maintenance Procedures**

- a. Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.
- b. Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

**4. Category 4 - Wiring and Loop Diagrams**

- a. Diagrams: This category includes complete internal and connection wiring diagrams for electrical and instrumentation equipment items.

**5. Category 5 - Shop Drawings**

- a. Drawings: This category includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

**6. Category 6 - Parts List**

- a. Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.
- b. Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

**7. Category 7 - Safety**

- a. Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

**8. Category 8 – Documentation & Warrantees**

- a. Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

**C. Format**

1. Each Technical Manual shall be bound in standard size 3 ring hardcover binders labeled on the spine and cover with project name, OWNER's project number, specification section number, equipment name, and equipment identification number
2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.
3. Documents in binders shall be 3-hole punched, no text shall be punched out, and pages larger than 8-1/2 inches by 11-inches shall be folded to 8-1/2 inches by 11-inches. Binder ring size shall not exceed 2.5-inches in diameter.
4. Each final set of Technical Manuals shall include a CD with electronic files:
  - a. Project specific files created in Microsoft Office, AutoCAD version 2018, Adobe Acrobat portable document format, or other software required by the specifications.
  - b. Manufacturer literature in Adobe Acrobat portable document format (pdf).

#### **D. Technical Manual Review Process**

1. The CONTRACTOR shall furnish three (3) draft Technical Manuals for each Specification Section that requires a Manual. The OWNER's RPR will retain one (1) copy, will forward one (1) copy to the OWNER, and will return one (1) copy to the CONTRACTOR with review comments.
2. The CONTRACTOR shall incorporate all comments into the draft and shall submit five (5) identical hard copies of the final Manual, bound in 3-ring binders, for acceptance.

#### **E. Schedule**

1. Except where indicated otherwise, Technical Manuals shall be submitted in final form to the OWNER's RPR not later than the 80 percent of construction completion date. Discrepancies found by the OWNER or ENGINEER shall be corrected within 30 Days from the date of written notification by the OWNER's RPR.

#### **1.6 SPARE PARTS LIST**

- A. The CONTRACTOR shall furnish to the OWNER spare parts information for mechanical, electrical, and instrumentation equipment. The spare parts list shall include those spare parts that each manufacturer recommends be maintained by the OWNER in inventory.
  1. **Sources and Pricing:** The spare parts list shall include a current list price of each spare part. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to assist the OWNER in ordering.
  2. **Format:** The CONTRACTOR shall cross-reference spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists

shall be bound in standard size, 3 ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

## 1.7 RECORD DRAWINGS

- A. The CONTRACTOR shall maintain one set of Drawings at the Site for the preparation of record drawings. On these, it shall mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.
- B. The record drawings shall be supplemented by any detailed sketches as necessary or as CONTRACTOR is directed, to fully indicate the WORK as actually constructed. These record drawings are the CONTRACTOR's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up to date during the progress of the WORK. Red ink shall be used for alterations and notes. Notes shall identify relevant Change Orders by number and date.
- C. 11-inch x 17-inch size paper copies of the record drawings shall be submitted to the OWNER's RRP at 120-day intervals, starting after the date of the Notice to Proceed, and also at completion of WORK. Failure to submit complete record drawings on or before these dates will enact the liquidated damages clause for interim record drawing submittals described in Division 00 Contract Specifications.
- D. In the case of those drawings that depict the detail requirement for equipment to be assembled and fabricated in the factory, the record drawings shall be updated by indicating those portions which are superseded by change order drawings or final Shop Drawings, and by including appropriate reference information describing the change orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.
- E. Disorganized or incomplete record drawings will not be accepted. The CONTRACTOR shall revise them and resubmit the drawings for review.
- F. Record drawings shall be accessible to the OWNER's RPR during the construction period.
- G. Final payment will not be acted upon until the record drawings have been completed and delivered to the OWNER's RPR. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information overlaid on the Contract Drawings.
- H. Information submitted by the CONTRACTOR will be assumed to be correct, and the CONTRACTOR shall be responsible for the accuracy of such information

## 1.8 QUALITY CONTROL (QC) SUBMITTALS

- A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the OWNER and ENGINEER that the CONTRACTOR has satisfied certain requirements of the Contract Documents.

- B. Unless otherwise indicated, QC submittals shall be submitted:
1. Before delivery and unloading, for the following types of submittals:
    - a. Manufacturers' installation instructions
    - b. Manufacturers' and Installers' experience qualifications
    - c. Affidavits and manufacturers' certification of compliance with indicated product requirements
    - d. Laboratory analysis results
    - e. Factory test reports
    - f. Ready mix concrete delivery tickets
    - g. Design calculations
  2. Within 30 Days of the event documented for the following types of submittals:
    - a. Manufacturers' field representative certification of proper installation
    - b. Field measurement
    - c. Field test reports
    - d. Receipt of permit
    - e. Receipt of regulatory approval
- C. The OWNER's RPR and ENGINEER will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

#### 1.9 INFORMATIONAL SUBMITTALS

- A. Informational submittals, such as Requests for Information (RFI), Deviation Request (DR), Change Order Proposals (COR), etc. formalize the flow of information between the CONTRACTOR and the ENGINEER. The OWNER's standard forms will be employed for such purpose. Electronic copies of all standard Construction Management forms shall be provided by the OWNER to the CONTRACTOR.

#### 1.10 CONSTRUCTION PHOTOGRAPHS

- A. The CONTRACTOR shall be responsible to take digital construction photographs, no less than once per week, showing the progress of the WORK, including documentation of all buried utilities encountered during construction as well as installation of new buried utilities and buried WORK required by the Contract.

- B. Upon completion of the WORK and before final payment, the CONTRACTOR shall electronically submit all photographs to the OWNER on a SharePoint site or other electronic media with each photograph's file name identified by location and date it was taken.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## **SECTION 01 40 00 - QUALITY REQUIREMENTS**

### **PART 1 -- GENERAL**

#### **1.1 QUALITY CONTROL**

- A. The CONTRACTOR shall provide tests and reports described in this section with any tests, reports, and other information that may be additionally required in any section of the specifications.

#### **1.2 TESTS BY INDEPENDENT TESTING LABORATORY**

##### **A. Testing Laboratory**

- 1. The OWNER will select and direct an independent construction inspector and testing laboratory (Testing Lab) to perform inspection and testing services as described in this Section. The construction inspector and testing laboratory will work solely at the direction of the OWNER's own Quality Assurance program. The CONTRACTOR shall include the cost in the price proposal to provide his own testing services program.

##### **B. The CONTRACTOR shall:**

- 1. Make available and deliver to Testing Lab, at the CONTRACTOR's expense, all materials to be tested. The CONTRACTOR shall be responsible for coordinating all testing.
- 2. Provide labor necessary to supply samples and assist in making tests.
- 3. Advise Testing Lab of the identity of material sources and instruct suppliers to allow inspections by the laboratory if so desired by the OWNER.

##### **C. The testing lab is not authorized to:**

- 1. Release, revoke, alter or enlarge on, contract requirements.
- 2. Approve or accept any portion of the work.
- 3. Perform any duties required of the CONTRACTOR, including any testing work requested by the CONTRACTOR for verification.

- D. Tests shall be conducted in accordance with the requirements of the specifications as designated or, where not specified, as requested by the OWNER. All testing will be in accordance with the latest standards of American Society for Testing and Materials.

#### **1.3 INDEPENDENT TESTING LABORATORY SERVICES, TESTS AND RELATED CONTRACTOR RESPONSIBILITIES**

- A. Testing Lab Services will be performed for, though are not limited to, the following items:

- 1. Compacted Soils



- a. The Testing Lab will secure samples of onsite fills proposed for use or being used in construction and test for proper gradation (sieve analysis) in accordance with the applicable sections of these specifications. This will also be done on CONTRACTOR provided samples from offsite borrow sources.
- b. The Testing Lab will establish optimum moisture – density relationship in accordance with ASTM D698 (Standard Proctor).
- c. The OWNER reserves the right to make or request in-situ tests of fills and backfills at any time, above those require by the CONTRACTOR, in order to determine compliance with the specifications.

## 2. Concrete

- a. The Testing Lab will test samples of aggregates CONTRACTOR proposes to use for compliance with specifications.
- b. The OWNER will verify compliance with the specifications for cement proposed for use by the CONTRACTOR based on data submitted by the CONTRACTOR.
- c. The Testing Lab will review the CONTRACTOR's proposed design concrete mix, as well as perform appropriate laboratory tests during construction, including compression tests of cylinders and slump test, if required, to substantiate mix designs.
- d. When requested by the OWNER, the Testing Lab will inspect and collect test materials during concrete work to substantiate compliance with specifications and mix requirements.
- e. Slump Test
  - 1) The right to perform or request a slump test by the CONTRACTOR at any time, which may be in addition to the CONTRACTOR's testing, is reserved for the OWNER.
  - 2) Test cylinders shall be prepared and supplied by the CONTRACTOR as required by SECTION 03 30 00 as follows:
    - a) Each set of test cylinders shall consist of three cylinders prepared by the Contractor.
    - b) Test cylinders shall be made and cured by the Contractor in conformity with ASTM C31. No sooner than 24 hours, but no more than 48 hours, after taking cylinders, the Contractor shall carefully transport the cylinders to the Testing Laboratory for moisture curing.
- f. The Testing Lab will perform the required number of compression tests as follows:
  - 1) Test one cylinder to failure at 7 days.

- 2) Test two (2) cylinders at 28 days in accordance with ASTM C39 and SECTION 03 30 00 of these specifications.
- g. The CONTRACTOR shall identify all test cylinders with symbols to indicate location on the job where concrete test was made. Symbols will be used to record placement locations on record drawings.
3. The Testing Lab will verify roadway Aggregate Gradation and Compaction in Accordance with applicable specifications.

#### 1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Furnish product data meeting or exceeding contract requirements in accordance with the applicable specifications.
- B. Cooperate with any of OWNER and Testing Lab personnel, in providing access to work and to manufacturer's or suppliers operations.
  1. Direct CONTRACTOR's representative, if desired, to monitor each inspection, sampling and test.
  2. The CONTRACTOR shall, within 24 hours, notify the OWNER in writing of reasons for not acknowledging field testing and sampling procedures.
- C. Provide to the Testing Lab, initial representative samples of materials to be tested, in specified quantities.
- D. Furnish copies of mill test reports.
- E. Furnish verification of compliance with contract requirements for materials and equipment.
- F. Furnish labor and facilities:
  1. To provide access to work to be tested.
  2. To obtain, handle and transport samples at site.
  3. To facilitate inspections and tests.
  4. For the Testing Lab's exclusive use for storage and pouring of concrete test samples.
- G. Notify the OWNER, Construction Inspector, and the Testing Lab sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests. A minimum of two (2) days advance notice will be provided. CONTRACTOR shall notify the OWNER, Construction Inspector and the Testing Lab when work is ready for testing. The CONTRACTOR shall provide a schedule for the Testing Lab for acceptance by the Construction Inspector and OWNER. The CONTRACTOR shall pay for any testing he or any of his representatives or employees schedule as defined in these specifications.

- H. Work which is defective, or which fails to conform to the contract documents shall be corrected by the CONTRACTOR at the CONTRACTOR's sole expense. Corrective work shall not be cause for delay in the project schedule or the work of another CONTRACTOR.
- I. Pay all costs of retesting when test results indicate non-compliance with contract requirements.
- J. Restore all surfaces and areas disturbed by testing operations to conditions existing before testing.

#### 1.5 QUALIFICATIONS FOR WELDING WORK

- A. Welders employed in executing work under this project shall possess qualification papers given by an independent testing laboratory under AWS Code, Standard Qualifications Procedure.
- B. The qualification papers shall be dated no earlier than six months prior to the start of the project. Welders not engaged in welding for a period of three or more months within the 6 months preceding construction must be re-qualified.

- END OF SECTION -

## SECTION 01 42 10 - REFERENCE STANDARDS

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. **Titles of Sections and Paragraphs:** Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.
- B. **Applicable Publications:** Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.
- C. **Specialists, Assignments:** In certain instances, specification text requires (or implies) that specific WORK is to be assigned to specialists or expert entities who must be engaged to perform that WORK. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also, they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of WORK is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the CONTRACTOR.

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

- A. The CONTRACTOR shall construct the WORK in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.
- B. References to "Building Code", "International Building Code", or "California Building Code" shall mean California Building Code as amended by the local jurisdiction. Similarly, references to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Association of Plumbing and Mechanical Officials (IAPMO) as amended by the local jurisdiction. "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the WORK is advertised for Bids shall apply to the WORK herein, including all addenda, modifications, amendments, or other lawful changes thereto.

- C. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and direction prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.
- D. References to "OSHA Regulations for Construction" shall mean **Title 29, Part 1926, Construction Safety and Health Regulations**, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
- E. References to "OSHA Standards" shall mean **Title 29, Part 1910, Occupational Safety and Health Standards**, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
- F. **Applicable Safety Standards:** References to "Cal-OSHA" shall mean State of California, Department of Industrial Relations, Construction Safety Orders, as amended to date, and all changes and amendments thereto.

### 1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

- A. The CONTRACTOR shall be responsible that all WORK included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.
- B. Where no specific regulations exist and the OWNER has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

### PART 2 -- PRODUCTS (NOT USED)

### PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

## SECTION 01 42 13 - ABBREVIATIONS OF INSTITUTIONS

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of the Specifications, the following acronyms or abbreviations which may appear shall have the meanings indicated herein.

#### 1.2 ABBREVIATIONS

AA	Aluminum Association
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Bearing Manufacturer's Association – ABMA
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ADM	Aluminum Design Manual
AF&PA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMA	Acoustical Material Association
AMCA	Air Movement and Control Association International, Inc
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials

AWCI	American Wire Cloth Institute
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association
CABO	Council of American Building Officials
CBC	California Building Code
CCOR	California Code of Regulations
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLPCA	California Lathing and Plastering Contractors Association
CMAA	A division/section of the Material Handling Industry of America
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drilling Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EI	Energy Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
ETL	Electrical Test Laboratories
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FEMA	Federal Emergency Management Association
FHWA	Federal Highway Administration
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HSWA	Federal Hazardous and Solid Waste Amendments
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
ICCEC	Electrical Code
ICC-ES	International Code Council Evaluation Service
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code, Association Connecting Electronic Industries
IRC	International Residential Code
ISA	Instrument Society of America
ISDI	Insulated Steel Door Institute

ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
ITU-T	Telecommunications Standardization Sector of the International Telecommunications Union
LPI	Lightning Protection Institute
LRQA	Lloyd's Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
DASMA	Door and Access Systems Manufacturers Association International
NAPF	National Association of Pipe Fabricators
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NCCLS	National Committee for Clinical Laboratory Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association
NISO	National Information Standards Organization
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastic Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service, a division of the California Redwood Association, CRA
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
RWQBC	Regional Water Quality Control Board
SAE	Society of Automotive Engineers
SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricator's Association
SPIB	Southern Pine Inspection Bureau
SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction



STLE	Society of Tribologists and Lubricating Engineers
TAPPI	Technical Association of the Worldwide Pulp, Paper, and Converting Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
USACE	United States Army Corps of Engineers
WCLIB	West Coast Lumber Inspection Bureau
WDMA	National Window and Door Manufacturers Association
WEF	Water Environment Federation
WI	Woodwork Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## SECTION 01 57 20 - TEMPORARY ENVIRONMENTAL CONTROLS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. WORK includes furnishing all labor, materials and equipment required for the installation and maintenance of temporary environmental controls, including erosion and sediment controls.

#### 1.2 SUBMITTALS

- A. Storm Water Pollution Prevention Plan (SWPPP): Submit a SWPPP indicating storm water pollution prevention measures, erosion and sediment control measures and products, as well as installation, maintenance, repair, and removal procedures.
- B. Notice of Intent (NOI).

#### 1.3 DUST ABATEMENT

- A. The CONTRACTOR shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity of the Site. The CONTRACTOR shall be responsible for any damage resulting from dust originating from its operations. Dust abatement measures shall be continued until the CONTRACTOR is relieved of further responsibility by the ENGINEER.
- B. **Storage Piles:** Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e. gravel, sand, dirt) with a silt content of 5 percent or greater.
- C. **Active Areas of Site:** Water active construction areas and unpaved roads as needed and as requested by ENGINEER.
- D. **Inactive Areas of Site:** Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.
- E. **Vehicle Loads:** Cover or maintain at least 2-feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.
- F. **Roads:** When there is visible track-out onto a paved public road, install approved Best Management Practices where the vehicles exit and enter onto the paved roads. Sweep the paved street at the end of each shift with a water spray pick-up broom-type street sweeper as necessary or as directed.
- G. **Vehicle Speeds:** If watering of unpaved roads is not sufficient to control dust, reduce vehicle speeds as necessary to control dust.

#### 1.4 STORMWATER POLLUTION PREVENTION

- A. CONTRACTOR shall minimize stormwater pollution from the Site in accordance with this Section and with the Storm Water Pollution Prevention Plan.

#### 1.5 RUBBISH CONTROL

- A. During the progress of the WORK, the CONTRACTOR shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The CONTRACTOR shall dispose of rubbish and waste materials of any nature and shall establish regular intervals of collection and disposal of such materials and waste. The CONTRACTOR shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with applicable safety laws and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

#### 1.6 SANITATION

- A. **Toilet Facilities:** Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets shall conform to the requirements of Part 1926 of the OSHA Safety and Health Regulations for Construction.
- B. **Sanitary and Other Organic Wastes:** The CONTRACTOR shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the Site in a manner satisfactory to the ENGINEER and in accordance with Laws and Regulations pertaining thereto.

#### 1.7 CHEMICALS

- A. Chemicals used on the WORK or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in paragraph 6.11 of the General Conditions.

#### 1.8 CULTURAL RESOURCES

- A. The CONTRACTOR's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").
- B. In the event potential cultural resources are discovered during subsurface excavations at the Site, the following procedures shall be instituted:

1. The OWNER will issue a temporary Notice to Suspend Work directing the CONTRACTOR to cease construction operations at the location of such potential cultural resources find.
  2. The suspension Notice will contain the following:
    - a. A clear description of the WORK to be suspended
    - b. Instructions regarding issuance of further orders by the CONTRACTOR for material services
    - c. Guidance as to the action to be taken on subcontracts
    - d. Suggestions to the CONTRACTOR to minimize incurred costs
    - e. Estimated duration of the temporary suspension.
  3. Such suspension shall be effective until such time as a qualified archeologist can assess the value of the potential cultural resources and make recommendations to the State Water Resources Control Board Cultural Resources Officer.
  4. The OWNER will implement appropriate actions as directed by the State Board Cultural Resources Officer or Project Manager. The CONTRACTOR shall cease WORK in the area of a discovery until appropriate actions have been determined in accordance with this paragraph.
  5. If human remains are discovered, WORK in the immediate vicinity of the find shall stop. The Local Law Enforcement Agency shall be notified (Section 7050.5 of the California Health and Safety Code).
- C. If the archeologist determines that the potential find is a bonafide cultural resource, at the direction of the State Water Resources Control Board Cultural Resources Officer, the OWNER will extend the duration of the suspension.
- D. Changes to the Contract Price and Contract Times for suspension due to discovery of a potential cultural resource will be made in the following manner:
1. Contract Times
    - a. If the WORK temporarily suspended is on the "critical path", the total number of Days for which the suspension is in effect will be added to the Contract Times.
    - b. If a portion of WORK at the time of such suspension is not on the "critical path", but subsequently becomes WORK on the critical path, the Contract Times will be computed from the date such WORK is classified as on the critical path.
  2. Contract Price
    - a. If, as a result of a cultural resources suspension, the CONTRACTOR sustains a loss that could not have been avoided by judicious handling of forces and equipment or redirection of forces or equipment to perform other WORK on the

contract, there will be paid an amount based on time and materials for the loss in accordance with the following:

- 1) Idle Time of Equipment: Compensation for equipment idle time will be determined in accordance with the General Conditions for equipment time and equipment rental time.
  - 2) Idle Time of Labor: Compensation for idle time of workers will be determined in accordance with the General Conditions for labor.
- b. Costs of labor will be compensated only to the extent such cost was in fact caused by the suspension.
  - c. Compensation for loss due to idle time of either equipment or labor will not include markup for profit.
  - d. The hours for which compensation will be paid will be the actual normal working time during which such suspension lasts but will in no case exceed eight hours in any single Day.
  - e. The days for which compensation will be paid exclude Saturdays, Sundays, and legal holidays during the suspension.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## SECTION 01 60 00 - PRODUCTS, MATERIALS, EQUIPMENT AND SUBSTITUTIONS

### PART 1 -- GENERAL

#### 1.1 DEFINITIONS

- A. The word "Products," as used in the Contract Documents is defined to include purchased items for incorporation into the WORK, regardless of whether specifically purchased for the project or taken from CONTRACTOR's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form WORK. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.
- B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the WORK.

#### 1.2 QUALITY CONTROL

- A. **Source Limitations:** To the greatest extent possible for each unit of WORK, the CONTRACTOR shall provide products, materials, and equipment of a singular generic kind from a single source.
- B. **Compatibility of Options:** Where more than one choice is available as options for CONTRACTOR's selection of a product, material, or equipment, the CONTRACTOR shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

#### 1.3 PRODUCT DELIVERY AND STORAGE

- A. The CONTRACTOR shall deliver and store the WORK in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the CONTRACTOR shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

#### 1.4 TRANSPORTATION AND HANDLING

- A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

- B. The CONTRACTOR shall provide equipment and personnel to handle products, materials, and equipment including those furnished by OWNER, by methods to prevent soiling and damage.
- C. The CONTRACTOR shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

#### 1.5 STORAGE AND PROTECTION

- A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate-controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.
- B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.
- C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.
- D. Storage shall be arranged to provide access for inspection. The CONTRACTOR shall periodically inspect to assure products are undamaged and are maintained under required conditions.
- E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

#### 1.6 MAINTENANCE OF PRODUCTS IN STORAGE

- A. Stored products shall be periodically inspected on a scheduled basis. The CONTRACTOR shall maintain a log of inspections and shall make the log available on request.
- B. The CONTRACTOR shall comply with manufacturer's product storage requirements and recommendations.
- C. The CONTRACTOR shall maintain manufacturer-required environmental conditions continuously.
- D. The CONTRACTOR shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.
- E. For mechanical and electrical equipment, the CONTRACTOR shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.
- F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the OWNER in accordance with the Contract Documents.

## 1.7 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

- A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:
1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the CONTRACTOR.
  2. The ENGINEER will be the sole judge as to the type, function, and quality of any such substitution and the ENGINEER's decision shall be final.
  3. The ENGINEER may require the CONTRACTOR to furnish additional data about the proposed substitution.
  4. The OWNER may require the CONTRACTOR to furnish a special performance guarantee or other surety with respect to any substitution.
  5. Acceptance by the ENGINEER of a substitution item proposed by the CONTRACTOR shall not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.
  6. The CONTRACTOR shall pay all costs of implementing accepted substitutions, including redesign and changes to WORK necessary to accommodate the substitution.
- B. The procedure for review by the ENGINEER will include the following:
1. If the CONTRACTOR wishes to provide a substitution item, the CONTRACTOR shall make written application to the ENGINEER on the "Substitution Request Form."
  2. Unless otherwise provided by law or authorized in writing by the ENGINEER, the "Substitution Request Form(s)" shall be submitted within the 35 Day period after award of the Contract.
  3. Wherever a proposed substitution item has not been submitted within said 35 Day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the ENGINEER, the CONTRACTOR shall provide the material or equipment indicated in the Contract Documents.
  4. The CONTRACTOR shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.
  5. The ENGINEER will evaluate each proposed substitution within a reasonable period of time.



6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the ENGINEER'S prior written acceptance of the CONTRACTOR'S "Substitution Request Form."
  7. The ENGINEER will record the time required by the ENGINEER in evaluating substitutions proposed by the CONTRACTOR and in making changes by the CONTRACTOR in the Contract Documents occasioned thereby.
- C. The CONTRACTOR's application shall address the following factors which will be considered by the ENGINEER in evaluating the proposed substitution:
1. Whether the evaluation and acceptance of the proposed substitution will prejudice the CONTRACTOR's achievement of Substantial Completion on time.
  2. Whether acceptance of the substitution for use in the WORK will require a change in any of the Contract Documents to adapt the design to the proposed substitution.
  3. Whether incorporation or use of the substitution in connection with the WORK is subject to payment of any license fee or royalty.
  4. Whether all variations of the proposed substitution from the items originally specified are identified.
  5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.
  6. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.
  7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.
- D. Without any increase in cost to the OWNER, the CONTRACTOR shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the CONTRACTOR's purchase thereof for incorporation in the WORK, whether or not the ENGINEER accepts the proposed substitution or proposed equipment or material. The CONTRACTOR shall reimburse the OWNER for the charges of the ENGINEER for evaluating each proposed substitution.

## **PART 2 -- PRODUCTS (NOT USED)**

## **PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## **SECTION 01 74 30 - PRESSURE PIPE TESTING**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall test water pipelines and appurtenant piping, in accordance with the Contract Documents.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. **Furnish:**
  - 1. A testing plan and schedule, including method for water conveyance, control, and disposal shall be submitted in writing for approval.

### **PART 2 -- PRODUCTS**

#### **2.1 MATERIAL REQUIREMENTS**

- A. All test equipment, temporary valves, bulkheads, and other water control equipment shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

- A. Water for testing water pipelines will be furnished by the CONTRACTOR and the CONTRACTOR shall convey the water from the designated source to the points of use.
- B. All pressure pipelines shall be tested. All testing operations shall be performed in the presence of the ENGINEER.
- C. Disposal of flushing water shall be by methods acceptable to the ENGINEER.

#### **3.2 HYDROSTATIC TESTING OF PIPELINES**

- A. Pipeline 30-inches diameter and larger shall be visually inspected that all debris has been removed prior to flushing.
- B. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate 1,000-foot segments. Sections that have a zero-leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained

an age of 14 Days, where applicable. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit. After completion of the tests, such taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

- C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under static head pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.
- D. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5-psi below test pressure during the test period.
- E. The maximum leakage for yard piping shall be as indicated on the Piping Schedule. Pipe with welded joints shall have no leakage. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

- END OF SECTION -

## **SECTION 01 75 00 - STARTUP**

### **PART 1 -- GENERAL**

#### **1.1 GENERAL**

- A. Plant startup is prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.
- B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the ENGINEER prior to requesting Substantial Completion from the ENGINEER. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup
- C. Startup of a fish hatchery is a complex operation requiring the combined expertise of the CONTRACTOR, Subcontractors, the ENGINEER, the OWNER, and OPERATOR. The CONTRACTOR shall be responsible for coordinating all parties for a successful startup: the ENGINEER, OWNER, and OPERATOR will be available for technical and operational advice prior to and during startup.
- D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.
- E. Temporary facilities may be necessary. If so, CONTRACTOR shall design, provide, operate, and later decommission them.
- F. During startup, effluent shall be discharged to Fall Creek via the fish ladder. If pollutants are laden within the effluent, flow shall be directed to the settling ponds.

#### **1.2 DEFINITIONS**

- A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer's services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.
- B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment and auxiliary systems, including related components, sub-systems, and systems operate properly and consistent with their intended function. Pre-commissioning involves balancing, adjustments, calibration, loop checks, and loop validation. Pre-commissioning shall simulate shutdown conditions, failure conditions, power fail and restart, bypass conditions, and failure resets. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer's certifications required by the Contract Documents are submitted and accepted by the ENGINEER. Pre-commissioning of all portions of the WORK shall be successfully completed prior to starting Commissioning.
- C. Commissioning is the verification that the complete WORK functions on an extended basis in full conformance with the Contract requirements.

### 1.3 SUBMITTALS

- A. **Schedule:** The schedule for startup shall be submitted under Section 01 32 15 - CPM Construction Schedule.
- B. **Startup Plan:** Not less than 60 Days prior to startup, submit for review a detailed Startup Plan. The CONTRACTOR shall revise the Plan as necessary based on review comments. The Plan shall include:
  - 1. Schedules for manufacturers' equipment certifications
  - 2. Schedules for submitting final Technical Manuals,
  - 3. Schedule for training the OPERATOR's personnel,
  - 4. Description of temporary facilities and schedule for installation and decommissioning them
  - 5. List of OWNER and CONTRACTOR-furnished supplies
  - 6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.
  - 7. Checklists and data forms for each item of equipment
  - 8. Address coordination with the OPERATOR's staff.
  - 9. Designate a representative of the CONTRACTOR who has the authority to act in matters relating to startup. The Plan shall also designate the roles and responsibilities of any Subcontractors that may be involved in startup activities.
  - 10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.
  - 11. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment. Schedule and plan shall indicate source of water, and testing sequence.
- C. **Records and Documentation:**
  - 1. Where required by the specifications, submit equipment installation certifications under those sections.
  - 2. Records of startup as indicated below.

## **PART 2 -- PRODUCTS (NOT USED)**

## **PART 3 -- EXECUTION**

### **3.1 MALFUNCTIONS**

- A. During the extended operational demonstrations, all components, subsystems, systems, and equipment must properly run continuously 24 hours per day at rates indicated by the ENGINEER throughout the test period. Unless indicated otherwise, if any item fails or malfunctions during the test, the item shall be repaired, and the test restarted at time zero with no credit given for the operating time before the failure or malfunction. Malfunctions satisfying all 3 of the following conditions will allow the demonstration period to resume at the elapsed time when the malfunction started:
1. Malfunction did not cause any interruption of the continuous operation of any other components, subsystems, systems, and equipment.
  2. Malfunction was corrected without causing or requiring any components, subsystems, systems, and equipment to cease operations.
  3. Malfunction was corrected within one hour of the time the malfunction was detected (the one-hour period includes the time required to locate the cause of the malfunction, beginning upon CONTRACTOR's notification from the ENGINEER that a malfunction has occurred and ending when the item is corrected and the system is successfully placed back into operation).
- B. The CONTRACTOR shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct malfunctions.

### **3.2 PREREQUISITES**

- A. Pre-commissioning and commissioning activities shall be scheduled according to Section 01 32 15. The 7 Day demonstrations and the 8 Day demonstration shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the OWNER's calendar.
- B. The following shall be completed before pre-commissioning begins.
1. All Technical Manual information required by the Contract Documents has been submitted.
  2. Safety equipment, emergency shower and eyewash units, fire extinguishers, gas detectors, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the Contract Documents are provided. Devices and equipment shall be fully functional, adjusted, and tested.
  3. Manufacturer's certifications of proper installation have been accepted.
  4. Leakage tests, electrical tests, and adjustments have been completed.

5. The ENGINEER has approved the Startup Plan.
6. Temporary facilities are functional, adjusted, and ready for use.
7. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.
8. Pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and other control devices to the settings determined by the ENGINEER or the equipment manufacturer have been adjusted for accuracy.
9. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified.

### 3.3 GENERAL

#### A. **Supplies**

1. The CONTRACTOR shall furnish:
  - a. Fuel
  - b. Oil and grease
  - c. Other necessary materials not listed for the OWNER to furnish
2. The OWNER will furnish:
  - a. Power

#### B. **Startup Records:** The CONTRACTOR shall maintain the following during testing and startup and submit originals to ENGINEER:

1. Lubrication and service records for each mechanical and electrical equipment item
2. Hours of daily operation for each mechanical and electrical equipment item
3. Equipment alignment and vibration measurement records
4. Logs of electrical measurements and tests
5. Instrumentation calibration and testing logs
6. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms
7. Factory and field equipment settings
8. Log of problems encountered, and remedial action taken

9. Other records, logs, and checklists as required by the Contract Documents

### 3.4 PRE-COMMISSIONING

- A. After individual equipment items and subsystems have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. Items of equipment shall be tested as part of a system to the maximum extent possible.
- B. Subject to the malfunction criteria above, each system shall be demonstrated for a continuous, 7 Day, 24 hour/day period. If any system malfunctions, the item or equipment shall be repaired, and the test restarted at time zero with no credit given for the elapsed time before the malfunction.
- C. The CONTRACTOR shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water or other process media, as applicable, to simulate the actual conditions of operation.
- D. Systems testing activities shall follow the detailed procedures and checklists in the Testing and Startup Plan. Completion of systems shall be documented by a report.
- E. The CONTRACTOR shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.
- F. Furnish the ENGINEER at least 10 Days written notice confirming the start of pre-commissioning. The OPERATOR's staff will observe pre-commissioning.

### 3.5 COMMISSIONING

- A. The CONTRACTOR shall start up the plant and operate it without malfunction for a continuous 8 Day, 24 hour/day period. The ENGINEER will determine the operational parameters. CONTRACTOR must be aware that Section 40 90 00 adds a 22 Day performance test period after the commissioning period.
- B. Defects that appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons that interrupt the test may, at the judgement of the ENGINEER, be cause for extending the demonstration an equal amount of time.
- C. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, and system tests have been completed to the satisfaction of the ENGINEER.
- D. During commissioning, the CONTRACTOR shall:
  - 1. Lubricate and maintain equipment in accordance with the manufacturers' recommendations.
  - 2. Clean or replace strainers, screens, and filter elements.



- END OF SECTION -

## **SECTION 01 77 00 - PROJECT CLOSEOUT**

### **PART 1 -- GENERAL**

#### **1.1 FINAL CLEANUP**

- A. The CONTRACTOR shall promptly remove from the vicinity of the completed WORK, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the WORK by the OWNER will be withheld until the CONTRACTOR has satisfactorily performed the final cleanup of the Site.

#### **1.2 CLOSEOUT TIMETABLE**

- A. The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

#### **1.3 TECHNICAL MANUAL SUBMITTAL**

- A. The CONTRACTOR's attention is directed to the condition that one percent of the Contract Price will be retained from any monies due the CONTRACTOR as progress payments, if at the 75 percent construction completion point, the approved Technical Manual complying with Section 01 33 00 has not been submitted. The aforementioned amount will be retained by the OWNER as the agreed, estimated value of the approved Technical Manual. Any such retention of money for failure to submit the approved Technical Manual on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to the CONTRACTOR under Article 14 of the General Conditions.

#### **1.4 FINAL SUBMITTALS**

- A. The CONTRACTOR, prior to requesting final payment, shall obtain and submit the following items to the ENGINEER for transmittal to the OWNER:
  - 1. Written guarantees, where required.
  - 2. Technical Manuals and instructions.
  - 3. New permanent cylinders and key blanks for all locks.
  - 4. Maintenance stock items; spare parts; special tools.
  - 5. Completed record drawings.
  - 6. Bonds for roofing, maintenance, etc., as required.
  - 7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

8. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

#### 1.5 MAINTENANCE AND GUARANTEE

- A. The CONTRACTOR shall comply with the maintenance and guarantee requirements contained in Article 13 of the General Conditions.
- B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the CONTRACTOR which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the CONTRACTOR shall have obtained a statement in writing from the affected private owner or public agency releasing the OWNER from further responsibility in connection with such repair or resurfacing.
- C. The CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from the OWNER. If the CONTRACTOR fails to make such repairs or replacements promptly, the OWNER reserves the right to do the WORK and the CONTRACTOR and its surety shall be liable to the OWNER for the cost thereof.

#### 1.6 BOND

- A. The CONTRACTOR shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 13 of the General Conditions.

#### **PART 2 -- PRODUCTS (NOT USED)**

#### **PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -

## **SECTION 02 15 00 - COFFERDAMS AND PROTECTIVE WORKS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The WORK includes furnishing all design, labor, and equipment necessary to construct and maintain in good working order all cofferdams and protective works necessary during construction of facilities located in or adjacent to static or moving bodies of water as specified herein.
- B. All cofferdam and related protective work shall be located within the approved disturbance area limits as shown on the Contract Drawings.
- C. Remove all temporary cofferdams or other temporary protective works upon completion of the facilities located in or adjacent to bodies of water.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. The CONTRACTOR shall submit a proposed plan for cofferdams and protective works in accordance with the requirements of Section 01 33 00 – Contractor Submittals which shall address, as a minimum, the following items:
  - 1. Type of cofferdam or other protective works to be used.
  - 2. Sequence of construction for cofferdam or other protective works-related Work items.
  - 3. Description of provisions for limiting siltation or other effects on the creek.
  - 4. Description of provisions for removal of temporary cofferdams or protective works and replacement or grading to design elevations shown on the Contract Documents following removal.
  - 5. Description of provisions for excavating and dewatering insides of the cofferdams or protective works, in accordance with Section 31 23 19 – Dewatering.
  - 6. Regulatory requirements for cofferdam and cofferdam-related activities.
  - 7. All calculations, assumptions, material properties, and other data required to substantiate the design of the cofferdam and protective works.
- B. The submittal shall be prepared and sealed by a Professional Engineer registered in the State of California experienced with cofferdam and related design.
- C. The plan shall be submitted for review a minimum of sixty (60) calendar days prior to beginning planned cofferdam work, shall be subject to review, permitting, and acceptance by governing authorities and the owners of any facilities utilized for water conveyance; as well as OWNER. However, these reviews shall not relieve the CONTRACTOR of full responsibility for the adequacy and stability of the cofferdams and protective works.

- D. Additionally, the CONTRACTOR shall submit a fish salvage plan concurrent with the cofferdam and protective works plan, describing:
  - 1. The anticipated order of activities for fish salvage operations behind the cofferdams prior to dewatering.
  - 2. The qualified, subcontracted biologists intended to carry out fish salvage operations.
  - 3. Equipment specifications intended for use in the fish salvage operations.

### 1.3 QUALIFICATIONS

- A. The CONTRACTOR shall demonstrate a minimum of ten (10) years' experience in the construction of shoring walls, in-water work, and cofferdams including, but not necessarily limited to experience with sheet piles, H piles, soldier pile walls, segmental (block) walls, earth fill cofferdams, and the associated planning, staging, and dewatering aspects thereof.

### 1.4 DEFINITIONS

- A. **Existing Ground.** The elevation of the existing ground surface before construction (including existing ground surfaces under water).
- B. **Finish Grade.** Represents the grade required by the Contract Documents to be the finished ground surface upon completion of construction.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. The type of construction used for cofferdams or other protective works (e.g., double-walled sheetpile cofferdams, tremie concrete, construction concrete block, or sandbag cofferdam) shall be at the choice of the CONTRACTOR, provided that the selected alternative fulfills the requirements of project permits and the Contract Documents. Cofferdam designs, configurations, or staging sequences that are substantially different than those shown on the Contract Documents require the CONTRACTOR to submit alternate design concepts such that the design and ownership team can evaluate design and permitting impacts.
- B. Cofferdams or other protective works shall be constructed, maintained, and removed using materials and methods that do not produce siltation or other degradation of the water quality of the creek which exceeds the limits of applicable federal, state, and local regulations.
- C. Cofferdams shall be designed and constructed of such a size that in no instance do they encroach within 10 feet of disturbed areas for other work.
- D. Sheet piling or any other methods requiring disturbance below original ground surface may not be used in any archeologically sensitive areas.

## 2.2 WOOD SHEETING

- A. Wood used for sheeting, shoring, and bracing will be sound; straight grained; free from shakes, loose knots, and other defects liable to impair its strength or durability; and will be Yellow Pine, Douglas Fir, or equivalent and will be either tongue-and-grooved or splined. Wood sheeting will not be less than nominal 2 inches thick.

## 2.3 STEEL SHEETING

- A. Steel sheeting will conform to ASTM A 328.

## 2.4 STRUCTURAL STEEL

- A. Temporary structural steel channels, angles, plates, and bars shall conform to ASTM A 36.
- B. Temporary structural steel W-Beams shall conform to ASTM A 992.
- C. Temporary structural steel rectangular HSS sections shall conform to ASTM A 500 Grade B.
- D. Temporary structural steel pipe sections shall conform to ASTM A 53 Grade B.

## 2.5 SANDBAGS IN WATER

- A. All temporary sandbags placed in water will conform to all applicable federal, state, and local laws and regulations.

## 2.6 CONSTRUCTION CONCRETE BLOCKS

- A. Construction concrete blocks shall be Ultrablock, Inc. or equivalent.

# **PART 3 -- EXECUTION**

## 3.1 COFFERDAMS

- A. Cofferdams shall be designed by the CONTRACTOR and construction methods will be selected by the CONTRACTOR. The design of the cofferdams will take into account the range of creek elevations which can be expected during the time allowed for in-water construction. The CONTRACTOR shall review available flow records to make this determination.
- B. Once the cofferdam is installed, the CONTRACTOR shall coordinate with their subcontracted biologists to perform a fish salvage process. The salvage will remove fish from behind the cofferdam or between cofferdams to be released back into the river. This will allow the area between cofferdams or behind a cofferdam to be completely dewatered during the river low flow periods. The CONTRACTOR shall follow the fish salvage plan that has been submitted and approved by the OWNER or ENGINEER and CDFW. The general process is assumed to be as follows:
  - 1. Prior to the cofferdam installation the fish salvage team shall use electro-fishers on a very low setting (non-stunning and moving downstream), to herd without capture.

Once the cofferdam is constructed the fish salvage team shall begin multiple pass shocking whining confined area to stun and remove all species of fish encountered. Species expected to encounter shall be *O. mykiss*, sculpin, suckers, and lamprey.

2. Site evaluation on arrival (weather / air and water temperatures).
  3. All crew members participating will be outfitted with waterproof waders and rubber neoprene gloves to protect against electric shock.
  4. Prior to sampling, stream temperature and conductivity will be recorded and used to set electro-fisher parameters (voltage, frequency, pulse) to manufacturer's recommended guidelines.
  5. Two netters will collect stunned fish and hold them in a 5-gallon bucket with bubble aerator. Fish are allowed to fully recover in the bucket before release downstream of the removal area.
  6. The fish salvage team will record total number of salmonids handled (by spp.) and total mortality for reporting, which is required for the project permit.
  7. Upon completion of each fish salvage event, the fish salvage team shall provide a report outlining the process and summarize the activity along with tabulated results of fish captured.
- C. Cofferdam areas shall be dewatered such that the bottoms of the excavations within the cofferdams are firm, free of standing water, and in all respects acceptable to the OWNER as foundation. The dewatering methods used shall prevent boiling, quick conditions, or softening of foundation strata and shall maintain the bottom of the excavation in a condition so that every phase of the WORK can be performed in the dry, with the exception of in-water work related to cofferdams and protective works as specified in the Contract Documents. Dewatering shall be performed in accordance with the requirements of Section 31 23 19 - Dewatering.
- D. After construction, the cofferdams shall be removed after areas are graded to finished grade, where indicated, or otherwise returned to existing grades; however, removal of cofferdams will not occur prior to the installation and backfill of all buried utilities which lie within 30 feet of the cofferdam areas. If options have been selected with below grade construction, it may be possible to cut off the structures at grade if the CONTRACTOR obtains approval of the appropriate jurisdictional authority.
- E. Any loss of water and any damage to ground, structures, facilities, fishery resources, or any other existing items that may be affected by the CONTRACTOR'S cofferdam operations, shall be the responsibility and liability of the CONTRACTOR and will be repaired or restored by the CONTRACTOR as required, to the OWNER'S satisfaction. Any damage or injury to a person directly or indirectly caused by the CONTRACTOR'S cofferdam operations shall be the responsibility of the CONTRACTOR.
- F. It is the CONTRACTOR's responsibility to design, install, and maintain functionally effective and structurally sound cofferdams. The failure of the cofferdam either in function or structurally for any reason, subsurface conditions inclusive, and the consequences of such a failure and liability for such a failure, will be the responsibility of the CONTRACTOR.

In the event the cofferdam has failed or is not functional as designed, the CONTRACTOR shall repair or rebuild the cofferdam at no additional cost to OWNER. Repairs or modifications to the cofferdams require additional design and construction submittals subject to the requirements of the Cofferdams and Protective Works Plan shown in this specification.

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## **SECTION 02 22 00 - SITE CONDITION ASSESSMENT**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall conduct thorough pre-construction and post-construction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, videotape recordings, and topographic mapping.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. Videotape surveys, photographs, and other data of the preconstruction conditions shall be submitted to the ENGINEER for record purposes prior to, but not more than three weeks before, commencement of any construction activities.
- C. Except as otherwise indicated, post-construction topographic mapping shall be submitted to the ENGINEER within 60 days of completing WORK.
- D. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the OWNER and ENGINEER.

### **PART 2 -- PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

#### **3.1 PHOTOGRAPHS AND VIDEO RECORDINGS**

- A. CONTRACTOR, as a minimum, shall document pre- and post-construction conditions by preparing videotape surveys of the following:
  - 1. Roadways used to access the Site or haul materials and equipment to the Site.
  - 2. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
  - 3. The existing lower raceway bank concrete slab, as shown on the Contract Drawings.
  - 4. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.
- B. Supplement videotape surveys with photographs and spot elevation surveys as required to thoroughly document the original condition and location of existing features and facilities.

- C. Videotape records shall be MP4 format.

### 3.2 TOPOGRAPHIC MAPPING

- A. Topographic mapping shall be developed using the Project coordinates, shall be referenced to the Project base lines and benchmarks, and shall be adequate to ascertain pre-construction and post-construction elevations of all public and private property within and adjacent to the construction limits.
- B. Topographic mapping shall be conducted to document the pre-construction topography of the Site:
  - 1. The existing upper raceway bank and outlet structure shall be surveyed as required to accurately depict the location, shape, and elevations of all walls, floor slabs, and the surrounding grade.
  - 2. The existing lower raceway bank and outlet structure shall be surveyed as required to accurately depict the location, shape, and elevations of all walls, floor slabs, pipes, sidewalks, structures, and the surrounding grade.
  - 3. The existing Dam A and Dam B shall be surveyed as required to accurately depict the location, shape, and elevations of the structures.
- C. Topographic mapping shall be conducted to document the post-construction topography of the Site:
  - 1. All areas of earthworks performed on site shall be surveyed in sufficient detail for accurate representation in the survey.
  - 2. All buildings and structures shall be surveyed in sufficient detail for accurate representation, including all foundations, tops of walls, concrete breaklines, appurtenances (e.g. bollards, fencing, etc.), and surrounding grade.
  - 3. All ponds and raceways shall be surveyed in sufficient detail for accurate representation, including floor slabs, concrete breaklines, pipe inverts, appurtenances (e.g. bollards, fencing, etc.), and surrounding grade.
  - 4. Modifications to Dams A and B shall be surveyed in sufficient detail for accurate representation, including concrete slabs, walls, gates, pipes, junctions with existing concrete, and surrounding grade.
- D. Spot elevation surveys used to document the elevation on abutting roadways, drives, and walks shall be taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the WORK.
- E. All pre- and post-construction topographic mapping and other data, including spot elevations, shall be prepared and sealed by a Professional Land Surveyor.
- F. All pre- and post-construction survey data shall be furnished as follows:

1. Site mapping shall be submitted as a separate electronic drawing in AutoCAD 2010 (Release 24), or later.
2. Each AutoCAD site map shall also be submitted in hard copy plot format (six copies).
3. ENGINEER will review hardcopy plots for accuracy relative to the indicated requirements.
4. CONTRACTOR shall amend mapping files as required, based on ENGINEER's comments.
5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 1-foot contour intervals as specified for National Map Accuracy Standards.
6. Electronic mapping files shall be three-dimensional.
7. Submit points lists for all topographic surveys in ASCII text file format.
8. All files shall be submitted as an electronic deliverable in a format and by a means acceptable by CONSTRUCTION MANAGER.
9. A backup of the files shall be made on two flash drives which shall be submitted to the OWNER and ENGINEER, respectively.

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## **SECTION 02 41 00 - DEMOLITION, SALVAGE, AND REHABILITATION**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall demolish and reconstruct existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

#### **1.2 COORDINATION**

- A. The CONTRACTOR shall carefully coordinate the WORK in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The WORK as indicated is not all inclusive, and the CONTRACTOR shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown.
- B. The CONTRACTOR shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. These record drawings have been reproduced to show existing conditions and to clarify the scope of WORK as much as possible. Prior to bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of auxiliary utilities. Existing hatchery water line locations are unknown but shall be demolished to accommodate new yard piping. CONTRACTOR shall verify the location of the hatchery water supply pipelines prior to construction.
- C. The CONTRACTOR shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the CONTRACTOR's employees. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the ENGINEER.

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Demolition Plan: Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the ENGINEER for approval. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included. Plan shall include state certified disposal facility that will be utilized for demolished materials.

#### 1.4 SITE CONDITIONS

- A. Locate existing services and underground structures that may affect the Work or may be damaged during demolition. Drawings or descriptions, verbal or otherwise, of existing structures or their location that are given are intended only as an aid to the location of these structures. Measurements and locations of the existing underground structures shown on the Drawings are not guaranteed to be accurate and must be verified by the Contractor prior to proceeding with demolition.
- B. Unknown Conditions
  - 1. Material, debris, and soils may be contaminated by hazardous substances not indicated on the Drawings or Contract Documents. Conduct an assessment to classify the extent of contaminated materials.
- C. Lead-based paint and asbestos:
  - 1. Structures, equipment, and buildings to be removed may include lead-based paint and asbestos. Lead-based paint and asbestos shall be removed prior to general demolition.

#### 1.5 DEMOLITION

- A. Existing pavement, structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.
- B. Items to be removed include:

Item	Description
Water Supply Flume	Demolish concrete water supply flume walls and slab, associated piping, intake screens and supports.
Storage Shed	Demolish and remove storage shed and concrete foundation.
Upper Raceway Piping and Walkways	Demolish and remove steel walkway grating, supports, ladders, and PVC piping.
Lower Raceway Concrete	Demolish and remove concrete walls down to existing slab. Maintain existing concrete slab. Burn back existing rebar 2 inches below the surface.

Lower Raceway Piping	Demolish PVC piping.
Lower Raceway Outlet Structure	Demolish concrete outlet structure walls, slab, and piping.
Incubation Shed	Demolish and remove building and concrete foundation.
Dam A	Demolish and remove dam wall, complete dam footing and cutoff wall as shown on contract drawings.

## 1.6 SALVAGE

- A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the ENGINEER. The CONTRACTOR shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.
- B. Items to be salvaged include:

Item	Description
Automatic Transfer Switch	Includes salvaging Kohler 240V, 260A, NEMA 3R switch
Propane Standby Generator – Circuit Breaker	Includes salvaging Schneider Electric 250A, 240V, 3-phase, 25 kA SCCR circuit breaker

## 1.7 RELOCATION

- A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated shall be removed from the Iron Gate Fish Hatchery (IGFH) site without any degradation in condition from that prior to removal. The CONTRACTOR shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

Items to be relocated include:

Item	Description
IGFH Spawn Building - Electro Anesthesia Tank System	6 ft long X 2 ft wide X 29 in deep tank and control system. Includes relocation of hydraulic motor/pump, hydraulic valves/manifold, hoist controls, and tank



	guide rails.
IGFH Spawn Building – Fish Crowder	Includes relocation of crowder and motors, cable reel, raise/lower limit switches, upstream/downstream limit switches, motor starters, and controls.
IGFH Spawn Building - Sorting Table	6 feet long X 21 inches wide X 34 inches tall and 7-inch side rails on each side of table. Includes relocation of table, attachments, foot pedal safety switch, and controls on sidewall to operate electro anesthesia tank.
IGFH Spawn Building - Chutes	Chute going from sort table to holding table. Chute measurement 16 inches wide X 48 inches long.  Chute going to conveyer belt is 24 inches wide X 6 feet long with 7-inch high side rails and one down the center to divide two separate chutes.
IGFH Spawn Building – Holding Table	Table is 4 feet wide X 5 feet long with 7-inch side rails on three sides of the table. Height of the table is 27 inches with adjustable legs.
IGFH Spawn Building – Air Spawn Table	Table is approximately 3 feet wide X 2 feet long. Includes relocation of table and appurtenant equipment.
IGFH Spawn Building – Conveyor Belt	Conveyor belt is 27 inches wide and connected in 10-foot segments. Includes relocation of (2) 10-foot segments of the frame, belt, motor, motor controls, and appurtenant equipment.
IGFH Spawn Building – Egg Rinse Table	Egg rinse and disinfecting area with a two-sided sink for rinsing eggs. Measurements are 8 feet long X 22 inches width X 34 inches tall. Includes relocation of table/sinks/frame and appurtenant components.
IGFH Spawn Building – Water Hardening Table	8 feet long X 29 inches wide X 27 inches tall. Includes relocation of table, supply and drainage manifold, and filters.
KRP Processing Table	Includes relocation of the processing table used by the Klamath River Project for testing and sampling.

Fish Screens	5'-0 3/8" x 4'-4" x 1 1/2". Qty – All.
Incubation Stacks	24 inches wide X 25" deep. Includes aluminum support frame and molded plastic trays. Qty – 142.
Propane Standby Generator	100 kW/125 kVA, 0.8 PF, 240V (reconfigurable to 480V), 3-phase, 4-wire. Includes relocation of entire generator skid with weatherproof enclosure.
Propane Tank	500-gallon. Includes relocation of tank.

#### 1.8 ABANDONMENT

- A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be abandoned shall be prepared by the CONTRACTOR as indicated.
- B. Items to be abandoned include:

Item	Description
Existing Water Supply Pipelines	The location of existing water lines on the Fall Creek Fish Hatchery site are unknown. Contractor shall demolish piping that is in interference with new infrastructure. Pipelines not exposed during construction activities may be abandoned in place.

#### 1.9 REHABILITATION

- A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.
- B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

#### 1.10 DISPOSAL

- A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

## **PART 2 -- PRODUCTS (NOT USED)**

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. The CONTRACTOR shall coordinate demolition and reconstruction WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.
- B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.
- C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

### **3.2 ENVIRONMENTAL CONSIDERATIONS**

- A. Dust and Debris Control:
  - 1. Dust from demolition and removal operations shall be controlled to not adversely affect people and equipment, including Others.
  - 2. Keep the site free of debris and control water runoff. Discharge water runoff such that is suspended with materials or other harmful substances in accordance with the requirements of local authorities. Prevent erosion and sedimentation per Specification Section 31 35 00 Erosion and Sediment Control General.
- B. Contain hazardous materials including dust, fibrous materials (insulation), contaminated or dangerous materials.

### **3.3 PROTECTION OF EXISTING FACILITIES**

- A. Before beginning any reconstruction, the CONTRACTOR shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the WORK. Existing facilities not subject to reconstruction shall be protected and maintained. Damaged existing facilities shall be repaired to the previous condition or replaced.
- B. Persons shall be afforded safe passages around areas of demolition.
- C. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall

remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.

- D. The CONTRACTOR shall carefully consider bearing loads and capacities before 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, the CONTRACTOR shall consult with the ENGINEER prior to the placement of such equipment or material.

### 3.4 DEMOLITION, SALVAGE, AND RELOCATION

- A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The CONTRACTOR shall verify the scope of the WORK to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:
  - 1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
  - 2. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Resultant openings in the structure shall be repaired as indicated.
  - 3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
  - 4. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.
  - 5. Connections to embedded electrical conduits shall be removed a minimum of 2-inches inside the finished surface of the existing structure. Wiring shall be removed, and the resulting openings shall be repaired as indicated.
  - 6. Associated instrumentation devices shall be removed.
  - 7. Auxiliary utility support systems shall be removed.
  - 8. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
  - 9. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.

10. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth which will not interfere with new construction, but not less than 36-inches below existing ground surface or future ground surface, whichever is lower.
  11. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 00 00 - Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
  12. When existing pipe is removed, the CONTRACTOR shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.
  13. When existing piping is removed from existing structures, the CONTRACTOR shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 0.5-inch and the recessed area filled with cement mortar grout.
  14. Electrical reconstruction shall be conducted by the CONTRACTOR in a safe and proper manner to avoid injury from electrical shock to the OWNER's and CONTRACTOR's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to CONTRACTOR, OWNER, or other personnel without suitable protection or warning signs.
- B. The CONTRACTOR shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The CONTRACTOR shall inform the ENGINEER in writing a minimum of 5 Days prior to the functional testing in order for the OWNER and ENGINEER to witness the test. If, in the opinion of the ENGINEER, the relocated equipment does not function in a satisfactory manner, the CONTRACTOR shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the OWNER.

### 3.5 ABANDONMENT

- A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill.

Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

### 3.6 REHABILITATION

- A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.
- B. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the CONTRACTOR shall score the edges of each opening (both sides of wall or floor slab) by saw-cutting clean straight lines to a minimum depth of 1-inch and then chipping out the concrete. Alternately, the sides of the opening (not the corners) may be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1-inch (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. Necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2-inches from the finished face of the new opening and be painted with epoxy paint. The inside face of the new opening shall be grouted with an epoxy cement grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.
- C. Where new piping is installed in existing structures, the CONTRACTOR shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
- D. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.
- E. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 0.5-inch and the recessed area filled with cement mortar grout.
- F. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

- G. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the CONTRACTOR shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-inches below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1.5-inches, and concrete within the scored lines removed to a depth of 1.5-inches (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.
- H. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:
  - 1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.
  - 2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-inches below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.
- I. Where existing handrailing is removed, post embedments and anchors shall be removed, and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.
- J. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00 - Protective Coatings to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00 - Protective Coatings.

### 3.7 DISPOSAL

- A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities which shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.
- B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these

structures shall remain prior to placing of backfill in the areas from which structures were removed.

- C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

### 3.8 OCCUPANCY AND POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.
- B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

### 3.9 CLEANING

- A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the ENGINEER or governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

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## SECTION 03 11 13 - CONCRETE FORMWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Manufacturer's information demonstrating compliance with requirements for the following:
  - 1. Form ties and related accessories, including taper tie plugs.
  - 2. Form gaskets.
  - 3. Form release agent, including NSF certification if not using mineral oil.
  - 4. Manufacturer's information on formwork, form materials, and locations for use.
- C. **Shop Drawings:** Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.
- D. **Falsework Calculations and Drawings:** The CONTRACTOR's attention is directed to the provisions of Section 1717 of the Division of Industrial Safety, Construction Safety Orders, as revised November 1973, which requires that all falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16-feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a Professional Engineer, registered in the State in which the falsework or vertical Shoring is to be used; provided further, that a copy of the falsework plan or shoring layout shall be available on the Site at all times.

#### 1.3 QUALITY CONTROL

- A. **Tolerances:** The variation from required lines or grade shall not exceed 1/4-inch in 10-feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood or fiberglass
Roof and floor	Plywood
All other WORK	Steel panels, fiberglass, plywood or tongue and groove lumber

- B. **NSF-61 Compliance.** Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

### 2.2 FORM AND FALSEWORK MATERIALS

- A. **Materials.** Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard
  2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.
  3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
  4. Steel leave in place forms shall not be used.
- B. **Chamfer Edges.** Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 0.5-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
- C. **Load Criteria.** Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50-psf minimum. The minimum design load for combined dead and live loads shall be 100-psf.

## 2.3 FORM TIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1.5 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **ST Snap Ties** by **MeadowBurke**; **A3 Snap Ties** by **Dayton Superior**, or approved equal.
- B. Taper ties shall be installed with the larger diameter installed on the inside face of water holding basins or side of wall with the greater water pressure. For dry building, taper ties shall be installed with larger diameter opening at the soil side of wall. After removal a preformed neoprene or polyurethane tapered plug sized to seat within the wall shall be inserted in the hole left by the removal of the taper tie for all walls exposed to retained soil or water. Plugs shall be recessed a minimum of 1.5-inches from the face of wall. All holes shall then be drypacked with grout unless approved otherwise by Engineer. Use **Taper Ties** by **MeadowBurke**, **D9 Taper Ties** by **Dayton Superior**, or approved equal.

## 2.4 FINISHING CONCRETE SURFACES

- A. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of Defective concrete, and treatment of surface defects.
  - 1. Surface holes larger than 1/2-inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.
  - 2. Basins and exposed walls shall be given a smooth finish as indicated below.
  - 3. Basins and exposed walls shall be given 2 coats of cement-based coating as indicated.

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. **Design Responsibility.** Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced.
  - 1. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained.
  - 2. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.
  - 3. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations.

4. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- B. **Quality Control & Bracing.** Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- C. All forms shall be removed, after the appropriate curing times have been obtained, unless approved otherwise by the ENGINEER.

### 3.2 FORM DESIGN

- A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.
1. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete.
  2. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1.0- to 1.5-inch diameter polyethylene rod held in position to the underside of the wall form.
  3. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER.
  4. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

### 3.3 CONSTRUCTION

- A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete

is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

- B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. **Form Ties**

1. **Embedded Ties:** Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.
2. **Removable Ties:** The larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

- A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

### 3.5 REMOVAL OF FORMS

- A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.
  - 1. For roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 30 00 - Cast-in-Place Concrete. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time.
  - 2. For vertical walls of water holding structures, forms shall remain in place at least 36 hours after the concrete has been placed.
  - 3. For parts of the WORK not specifically mentioned herein, forms shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

### 3.6 MAINTENANCE OF FORMS

- A. **General Condition.** Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned.
- B. **Form Oil.** The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

### 3.7 FALSEWORK

- A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, the requirements of the Construction Safety Orders of the California Division of Industrial Safety, and the requirements herein.
- B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

- C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20-tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

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## SECTION 03 20 00 - REINFORCEMENT STEEL

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide reinforcement steel and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

#### B. Shop Drawings

1. Shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication. The shop bending diagrams shall show the actual lengths of bars to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.
2. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement and the requirements herein.

#### 1.3 QUALITY CONTROL

- A. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcement steel in a quantity adequate for testing. Costs of initial tests will be paid by the OWNER. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

### PART 2 -- PRODUCTS

#### 2.1 MATERIAL REQUIREMENTS

- A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

#### 2.2 REINFORCEMENT STEEL

- A. **Reinforcement Steel ASTM Standards.** Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar and spiral reinforcement shall conform to ASTM A 615 - Deformed and Plain Billet - Steel Bars, for Grade 60 reinforcement unless otherwise indicated.

#### B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 0.5-inch from the concrete surface. Plastic shall be gray in color.
2. Concrete blocks (i.e. dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located. Wire ties shall be embedded in concrete block bar supports.

## 2.3 EPOXY GROUT

- A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements of Section 03 60 00 - Grout.

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the supplementary requirements herein.

### 3.2 FABRICATION

#### A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings. Bars shall be bent cold. Bars shall be bent per ACI 318.
2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings.

- B. **Fabricating Tolerances:** Bars used for concrete reinforcement shall satisfy the following fabricating tolerances:

1. Sheared length: plus and minus 1-inch
2. Depth of truss bars: plus zero, minus 0.5-inch
3. Stirrups, ties, and spirals: plus and minus 0.5-inch
4. Other bends: plus and minus 1-inch

### 3.3 PLACING

- A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.
- B. Limitations on the use of bar support materials shall be as follows.
  - 1. Concrete Dobies
    - a. Permitted at any location except where architectural finish is required.
    - b. Required for slabs on grade and surfaces in contact with or above ozonated process water.
  - 2. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.
  - 3. Plastic Bar Supports: permitted at every location except on grade.
- C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.
- D. Bars additional to those indicated that may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.
- E. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318 except where in conflict with the Building Code.
- F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.
- G. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

### 3.4 SPACING OF BARS

- A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.
- B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.
- C. In columns, the clear distance between longitudinal bars shall be not less than 1.5 times the bar diameter, nor less than 1.5 times the maximum size of the coarse aggregate, nor less than 1.5-inches.
- D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

### 3.5 SPLICING

#### A. **General**

- 1. Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER.
- 2. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

#### B. **Splices of Reinforcement**

- 1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.
- 2. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1.5 turns.

- C. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field bent except as indicated or specifically permitted by the ENGINEER.

### 3.6 CLEANING AND PROTECTION

- A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.
- B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be re inspected and, if necessary, recleaned.

### 3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

#### A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4-inch greater than the diameter of the outer surface of the reinforcing bar deformations.
2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.
3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.
4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.
5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

#### B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.
2. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

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## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide cast-in-place concrete in accordance with the Contract Documents.
- B. The term "hydraulic structure" used in these Specifications means environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.
- C. The following types of concrete are covered in this Section:

##### 1. **Structural Concrete**

- a. Regular Mix: Roof, floor slabs, columns, walls, pavements, and other concrete items not indicated otherwise in the Contract Documents.

##### 2. **Structural Silica-Fume Concrete**

- a. Silica Fume concrete shall contain a silica fume admixture per the Contract Documents and the silica fume manufacturer's recommendations.

- b. The following shall be constructed of structural Silica-Fume concrete

- 1) Dam A modifications
- 2) Dam B modifications
- 3) Intake structure
- 4) Fish Barrier Apron

- 3. **Sitework Concrete:** Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities unless otherwise indicated.

- 4. **Lean Concrete:** Concrete to be used for thrust blocks, pipe trench cut-off blocks, and cradles that are indicated on the Drawings as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connections.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. **Mix Designs:** Prior to beginning the WORK and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and



gradations of materials proposed for each class and type of concrete. Mix designs shall be checked through laboratory testing by an independent testing laboratory acceptable to the ENGINEER. Costs related to laboratory testing shall be CONTRACTOR's responsibility as part of the WORK.

- C. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.
- D. **Additional Submittals.** Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:
  - 1. Mill tests for cement.
  - 2. Admixture certification. Chloride ion content shall be included.
  - 3. Aggregate gradation test results and certification.
  - 4. Materials and methods for curing.

### 1.3 CONCRETE CONFERENCE

- A. The ENGINEER will chair a meeting to review the detailed requirements of the CONTRACTOR's proposed concrete design mixes and to determine the procedures for producing proper concrete construction no later than 14 Days after the Notice to Proceed.
- B. Parties involved in the concrete WORK shall attend the conference, including the following at a minimum:
  - 1. CONTRACTOR's representative
  - 2. Testing laboratory representative
  - 3. Concrete Subcontractor
  - 4. Reinforcing steel Subcontractor and detailer
  - 5. Concrete Supplier
  - 6. Admixture manufacturer's representative
- C. The conference shall be held at a time and place proposed by the CONTRACTOR and accepted by the ENGINEER. The conference shall be held at least 5 Days after agreement.

## 1.4 QUALITY CONTROL

### A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.
2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.
3. The cost of laboratory tests on cement, aggregates, and concrete shall be the CONTRACTOR's responsibility. The cost of laboratory tests on field-placed cement, aggregates, and concrete and the cost of Special Inspection required by Code will be the OWNER'S responsibility. However, the CONTRACTOR shall be responsible for the cost of any tests and investigations of WORK that is determined to be Defective WORK. The laboratory shall meet or exceed ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.
4. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

- B. **Inspections:** Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the ENGINEER will be required to comply with the Statement of Special Inspections to conform with code requirements. Costs of the special inspector shall be paid by the CONTRACTOR. Inspection reports shall be submitted to the ENGINEER.

### C. Field Compression Tests

1. Each set of specimens shall be a minimum of 5 cylinders.
2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field. Specimens shall be 6-inches diameter by 12-inches tall cylinders.
3. Frequency of Testing – Building Foundations
  - 1) Sampling frequency and testing for each class of concrete shall be in accordance with ACI 318 section 5.6 as follows:
    - a) Not less than once a day for each class of concrete placed, nor less than:
    - b) Once for each 150 yd<sup>3</sup> of each class of concrete placed each day, nor less than:

- c) Once for each 5,000 ft<sup>2</sup> of slab or wall surface area placed each day.
    - d) If total volume of concrete is such that frequency of testing would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
  - 2) Frequency of testing may be changed at the discretion of the ENGINEER.
- 4. Frequency of Testing – Hydraulic Structures
  - 1) Sampling frequency and testing for each class of concrete shall be in accordance with ACI 350 section 5.5 as follows:
    - a) Not less than once a day for each class of concrete placed, nor less than:
    - b) Once for each 100 yd<sup>3</sup> of each class of concrete placed each day, nor less than:
    - c) Once for each 5,000 ft<sup>2</sup> of slab or wall surface area placed each day.
    - d) If total volume of concrete is such that frequency of testing would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
  - 2) Frequency of testing may be changed at the discretion of the ENGINEER.
- 5. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinders will be held to verify test results, if needed.

#### **D. Evaluation and Acceptance of Concrete**

- 1. Evaluation and acceptance of the compressive strength of concrete will be according to ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality," and as indicated.
- 2. A statistical analysis of compression test results will be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
- 3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.
- 4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than

500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

5. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.
- E. **Aggregate Testing:** Aggregate testing shall be performed within 12 months of the start of construction and every 12 months during construction to determine continued compliance.
- F. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are different from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.
- G. **Floor Slab Hardener**
  1. Job Mockup: In a location designated by the ENGINEER, the CONTRACTOR shall place a 100 square foot floor mockup using the materials and procedures proposed for the WORK. Materials and procedures may be revised as necessary to obtain an acceptable surface, but the same materials and procedures shall be used in the WORK.
  2. Field Service: The CONTRACTOR shall obtain onsite proper usage advice from the surface hardener manufacturer while the job mockup is being placed and during initial placement of the WORK. Notify the surface hardener manufacturer at least 3 Days prior to initial use of the product.
  3. Installer Qualifications: Installer shall have a minimum of 3 years' experience and shall be specialized in application of dry shake surface hardeners.

## **PART 2 -- PRODUCTS**

### **2.1 CONCRETE MATERIALS**

#### **A. General**

1. Materials shall be classified as acceptable for potable water use according to NSF Standard 61.
2. Ready-mix concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.
3. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

4. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.
- B. Storage of materials shall comply with ACI 301, as applicable.
- C. **Materials.** Materials for concrete shall comply with ACI 301 and shall conform to the following requirements:
1. **Cement.** Cement shall be standard brand Portland cement conforming to ASTM C 150 –Portland Cement, for Type I/II or Type V. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.
  2. **Water.** Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (greater than 1000 mg/l TDS) shall not be used.
  3. **Aggregates.** Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates. Maximum size of coarse aggregate shall be as indicated. Substituting lightweight sand for fine aggregate will not be permitted.
    - a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined.
    - b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable. When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1.
    - c. Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation

characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. **Flyash.** If used, flyash shall be Class F and meet ASTM C618.

5. **Admixtures.** Admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion and shall be non-toxic after 30 days.

a. **Air-entraining agents:** Agents shall meet the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air-entraining admixture shall be approved by the ENGINEER prior to use.

b. **Set controlling and water reducing admixtures:** Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR's responsibility. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

1) Concrete shall not contain more than one water reducing admixture.

- 2) Set controlling admixture may be either with or without water-reducing properties. Admixture shall be appropriate for the air temperature at time of placement. Set controlling admixture shall be approved by the ENGINEER prior to use.
  - 3) Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used, and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations. Normal range water reducing admixtures shall be approved by the ENGINEER prior to use.
  - 4) High range water reducer shall conform to ASTM C 494, Type F or G. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio. High range water reducing admixtures shall be approved by the ENGINEER prior to use.
  - 5) If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3-inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.
  - 6) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.
6. **Lithium Additives:** Lithium additives shall not be used in concrete mix design for water bearing structures.
  7. **Silica Fume:** Silica fume shall conform to ASTM C 1240. Silica fume shall be approved by the ENGINEER prior to use. Blended cements with interground silica fume will not be allowed:
    - a. Water content of liquid slurry silica fume admixtures shall be considered as part of the mixing water when calculating the water/cement ratio.
    - b. Silica fume shall be added at the batch plant as recommended by the manufacturer. Regardless of the type of mixing equipment, mix times shall be increased by 40 percent over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94. For truck-mixed and central-mixed concrete, maximum allowable batch size shall be 80 percent of the maximum as called out by ASTM C 94.
  8. **Anti-washout Admixture for Underwater Concrete:** Anti-Washout Admixture shall be in accordance with US Army Corps of Engineers CRD-C 61. Contractor

shall use **MasterMatrix UW 450 anti-washout admixture** by **BASF** or approved equal.

a. Anti-washout Admixture shall be added at the batch plant or at the job site after all other concrete ingredients have been batched and thoroughly mixed as recommended by the manufacturer.

b. Anti-washout Admixtures shall be added with a water reducing admixture as recommended by the manufacturer.

D. **Alkali-Silica Reactivity (ASR) of Aggregates.** All aggregates used in the concrete mix designs shall generally be considered non-reactive (innocuous) aggregate according to the requirements of ASTM C1260 or ASTM 1567 and tested according to the requirements listed below.

1. Fine and coarse aggregates to be used in all concrete shall be evaluated individually and tested for alkali-aggregate reactivity, according to ASTM C1260. The average expansion of the mortar bars for the fine aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution. Likewise, the average expansion of the mortar bars for the coarse aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution.

2. If either of the aggregates do not pass the ASTM C1260 test requirements as described above, CONTRACTOR shall provide information to the CONTRACTOR that the proposed fine and coarse aggregate is the best (i.e. least reactive) locally available material within 50-100 miles of the project site. In addition, the CONTRACTOR shall provide additional testing of the proposed aggregates (fine and coarse) along with approved mitigating additives (i.e. fly ash, class N pozzolan, GGBF slag, silica fume or other approved additives) to the concrete mix design, according to the requirements of ASTM C1567 and the following requirements:

a. The concrete mix design parameters used in the ASTM C1567 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section. After 16-days of immersion in a 1N NaOH solution, the average expansion of the three mortar bars shall not exceed 0.10% as measured according to ASTM C1567 standards and protocol.

b. ASR test on both the fine and coarse aggregate and concrete mix additives (i.e. flyash, pozzolan, or other approved additives), sample bar preparation, testing and all analytical methods shall meet the ASTM C1567 testing procedural requirements.

c. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.

d. Results of the ASR test show that expansion of the concrete sample is less than 0.10% at 16-days after the start of the expansion test procedure.

e. Test results shall be reported to the CONTRACTOR and Design Engineer at 7-days, 11-days, and 16-days.



- f. The Concrete Supplier is still actively mining and using aggregate from the same representative portion of the aggregate pit from which the aggregate samples were taken for testing.
- 3. In lieu of the ASR testing above the aggregate may be tested in accordance with the requirements of ASTM C1293.
  - a. The concrete mix design parameters used in the ASTM C1293 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section.
  - b. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.
  - c. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 1-year for cement aggregate combinations to demonstrate aggregates to be non-reactive.
  - d. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 2-years for cement aggregate combinations with pozzolan or slag to demonstrate aggregates to be non-reactive

## 2.2 CURING MATERIALS

- A. Curing compounds shall be resin-based and compliant with local VOC requirements.
  - 1. Regular curing compounds shall be white pigmented and conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be approved by the ENGINEER prior to use.
  - 2. When curing compound must be removed for finishes or grouting, compounds shall be a dissipating type meeting ASTM C 309, type 1 or 2, Class B. Concrete curing compound shall be approved by the ENGINEER prior to use.
- B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.
- C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2-mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant). The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.
- D. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mils thick with white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when

determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

- E. Curing mats for use in Curing Method 6 below shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
- F. Evaporation retardant shall be a material such as **MasterKure ER 50** by **BASF**, **Eucobar** by **Euclid Chemical Company**, **L&M E-CON** by **Laticrete**, or equal.

## 2.3 NON-WATERSTOP JOINT MATERIALS

- A. Materials for non-waterstop joints in concrete shall conform to the following requirements:
  - 1. Preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03 32 00 - Joints in Concrete.
  - 2. Elastomeric joint sealer shall conform to Section 07 92 00 – Joint Sealants.
  - 3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth below, if testing is required by the ENGINEER.

## 2.4 FLOOR HARDENER (SURFACE APPLIED)

- A. Surface hardener shall be light reflective non-oxidizing metallic aggregate dry shake material that is premeasured, premixed, and packaged at the factory. Surface hardener shall be applied per the manufacturer's recommendations.
- B. Curing compound shall meet the moisture retention requirements of ASTM C 309 and the manufacturer recommendations.
- C. **Monomolecular Film:** Evaporation retarder shall be used to aid in maintaining concrete moisture during the early placement stages of plastic concrete. Evaporation retarder shall be as recommended by the surface hardener manufacturer.
- D. Floor hardener shall be approved by the ENGINEER prior to use.

## 2.5 MISCELLANEOUS MATERIALS

- A. **Damproofing Agents.** Damproofing agent shall be an asbestos-free, fibered asphalt emulsion intended for cold application to green concrete, both above and below grade. Damproofing shall meet the requirements of ASTM D 1227 – Emulsified Asphalt Used

as a Protective Coating for Roofing, Type II, Class I. Dampproofing shall be approved by the ENGINEER prior to use.

B. **Bonding Agents.** Bonding agents shall be epoxy adhesives conforming to the following:

1. For bonding freshly mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive** by **Sika Corporation**, **MasterEmaco ADH 326** by **BASF**, **Sure Bond J58** by **Dayton Superior**, or equal.
2. For bonding hardened concrete or masonry to steel, **Sikadur 31 Hi-Mod Gel** by **Sika Corporation**, **MasterEmaco ADH 327** by **BASF**, or equal.

C. **Vapor Retarder**

1. Vapor retarder shall be 30-mils thick, Class A, 3 ply, nylon or polyester cord-reinforced high-density polyethylene sheet laminated to a non-woven geotextile fabric, in accordance with ASTM E 1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
2. Granular Material Above Vapor Retarder: Crushed stone, gravel, or sand with the following size distribution and meeting the deleterious substance limits of ASTM C 33 for fine aggregates.

Sieve Size	Percentage Passing
3/8-inch	100
4.75 mm	85-100
No. 100	10 – 30

3. Seams in vapor retarder sheet shall be sealed with tape, adhesive, or other material as recommended by sheet manufacturer for the areas to be sealed and sheet material.

D. **Colorant.** Colorant for duct bank concrete shall be an integral red oxide coloring pigment used in the proportion of 8 pounds per cubic yard of concrete.

## 2.6 CONCRETE DESIGN REQUIREMENTS

- A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results. Changes shall be subject to review by the ENGINEER.

- B. **Fine Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

1. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50.
- C. Structural silica fume concrete shall contain 10 percent silica fume by weight of cement.
- D. Duct bank concrete shall contain an integral red-oxide coloring pigment. Concrete shall be dyed red throughout. Surface treatment to color duct banks will not be acceptable.
- E. **Water/Cement Ratio W/C:** The water/cement ratio indicated is for saturated-surface dry condition of aggregate. Every Day, throughout the day, the batch water added shall be adjusted for the total free water in the aggregates.
1. Total free moisture of aggregates shall be determined by:
    - a. Starting with the total moisture content of all aggregate, calculated by ASTM C 566 -Test Method for Total Moisture Content of Aggregate by Drying
    - b. Subtracting the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
    - c. Subtracting the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate

## F. Concrete Property Tables

<b>Structural Concrete</b>	
<b>Type of WORK</b>	<b>Regular Mix</b> (roof, floor slabs, walls, pavements, and other concrete items not categorized elsewhere)
<b>Min 28 Day Compressive Strength, psi</b>	4500
<b>Max Aggregate Size, in</b>	1
<b>Cement Content, lbs /cubic yard,</b>	564 to 600
<b>Max Allowable Fly Ash Content (FA); lbs/cubic yard</b>	Up to 120 (i.e. up to 15% max of cement content)
<b>Max W/C Ratio by weight</b>	0.42
<b>Total Air Content, percent</b>	4.5 to 7.5
<b>Slump, in</b>	3-in +/- 1-in with high range water reducer 7-in +/- 2-in

<b>Other Concrete</b>			
<b>Type of WORK</b>	<b>Structural Silica Fume Concrete</b> (concrete structures indicated to be S-F concrete)	<b>Sitework Concrete</b> (curbs, gutters, sidewalks, catch basins, fence embedment's, encasements, and ductbanks)	<b>Lean Concrete</b> (thrust blocks, pipe trench cut-off blocks, and cradles)
<b>Min 28 Day Compressive Strength, psi</b>	6000	3000	2000
<b>Max Aggregate Size, in</b>	1	1	1
<b>Cement Content per cubic yard, lb.</b>	564 to 600	470 min	376 min
<b>Max W/C Ratio by weight</b>	0.38	0.45	0.60
<b>Total Air Content, percent</b>	4.5 to 7.5	4 to 7	4.5 to 7.5
<b>Slump, in</b>	3-in +/- 1-in with high range water reducer 7-in +/- 2-in	3-in +/- 1-in ductbanks and encasements 5-in +/- 1-in	3-in +/- 1-in

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability and strength.

- G. **Adjustments to Mix Design:** The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with these Specifications.

## 2.7 CONSISTENCY

- A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as

necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete. The slumps shall be as indicated with the concrete properties.

## 2.8 TRIAL BATCH AND LABORATORY TESTS

- A. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements or approved historical concrete testing results as specified below.

1. **Trial Batch Concrete Testing.** Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR. Concrete shall conform to the requirements of this Section whether the aggregate proportions are from the CONTRACTOR's preliminary mix design or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch.

2. **Historical Concrete Testing.** For shrinkage testing as well as ASR expansion testing requirements, the CONTRACTOR may propose the use of historical test results on these tests provided that all of the following conditions are met:

a. The test results are no more than 6-months old from the project Notice-to-Proceed date.

b. The mix design used in the proposed historical tests has the same characteristics, as described below, as the mix design proposed for use on the project:

- 1) The type and quantity of cement used in the historical tested mix, is the same as that of the proposed mix design.
- 2) The quantity and source location of the coarse and fine aggregate used in the historical tested mix is the same as that of the proposed mix design. In addition, the aggregate used in the historical tests must be screened to the same gradations as that proposed for the project mix design.
- 3) The type and quantity of cementations substitutes (fly ash or slag or other approved substitute) used in the historical tested mix, is the same as that of the proposed mix design.
- 4) The water to cement ratio of the historical tested mix is within +/- 5% of the proposed water to cement ratio.

- 5) The air content of the historical tested mix is within 1% of the proposed air content (for example: for a proposed air content of 6% in the proposed mix design, the historical air content must be in the range of 5 to 7%.)
- 6) The same additives, including water reducing additives, that were used in the historical batch test results are being proposed for the new concrete mix design, and the proportions of those additives used in the historical mix design are within +/- 5% of that of the proposed project mix design.

B. **Compressive Strength Testing.** The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured, and tested in accordance with ASTM C 192 - Practice for Making and Curing Concrete Test Specimens in the Laboratory and ASTM C 39. Three compression test cylinders will be tested at 7 Days and 3 at 28 Days. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall not be less than 125 percent of the indicated compressive strength.

C. **Sieve Analyses.** A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates. Values shall be given for percent passing each sieve.

## 2.9 SHRINKAGE LIMITATION FOR STRUCTURAL CONCRETE

- A. The maximum concrete shrinkage for specimens cast as measured at 21 Day drying age or at 28 Day drying age shall be 0.042 percent or 0.050 percent, respectively. Standard deviation will not be considered. The CONTRACTOR shall only use a mix design for construction that has first met the shrinkage requirements. Shrinkage limitations apply only to structural concrete.
- B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the maximum shrinkage requirement by more than 25 percent.
- C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions to reestablish compliance. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water/cement ratio; washing of coarse and/or fine aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions to minimize shrinkage or the effects of shrinkage.

## 2.10 MEASUREMENT OF CEMENT AND AGGREGATE

- A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER. Weighing tolerances for the materials shall be a maximum of that given below.

Material	Percent of Total Weight
Cement	1
Aggregates	3



Admixtures	3
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## 2.11 MEASUREMENT OF WATER

- A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

## 2.12 READY-MIXED CONCRETE

- A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.
- B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.
- C. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be the resettable, recording type and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
- D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
- E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
- F. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph above entitled "Delivery Tickets."

- G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

## **PART 3 -- EXECUTION**

### **3.1 PROPORTIONING AND MIXING**

- A. **Proportioning:** Proportioning of the mix shall conform to ACI 301.
- B. **Mixing:** Mixing shall conform to ACI 301.
- C. **Slump:** Slumps shall be as indicated.
- D. **Retempering:** Retempering of concrete or mortar that has partially hardened shall not be permitted.

### **3.2 PREPARATION OF SURFACES FOR CONCRETING**

- A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. **Vapor Retarder Sheet**
  - 1. Sheet shall be installed under on-grade building floor slabs of occupiable (non-hydraulic) structures and at other locations indicated.
  - 2. Sand base shall be at least 2-inches thick within the foundation line after moistening and compaction by mechanical means. Sand surface shall be flat and level within a tolerance of plus zero inches to minus 3/4-inch.
  - 3. Place, protect, and repair defects in sheet according to ASTM E 1643 – Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs, and the manufacturer's written instructions. Seams shall be lapped and sealed in accordance with ASTM E 1643.
  - 4. Granular material above the sheet shall be moistened and compacted to 2-inches thickness within the same flatness criteria as the sand base.
- C. **Joints in Concrete:** Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed but placement of concrete has been stopped or interrupted and the ENGINEER has determined that the new concrete cannot be incorporated integrally with the concrete previously placed. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by

hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

- D. After the surfaces have been prepared, each approximately horizontal construction joint shall be covered with a 6-inch lift of a pea gravel mix. The mix shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.
- E. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK; provided that construction joints shall be made only where acceptable to the ENGINEER.
- F. **Embedded Items:** No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.
- G. Inserts or other embedded items shall conform to the requirements herein.
- H. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.
- I. **Anchor Rod Tolerances:** Anchor rods shall be placed to the tolerances in the AISC Code of Standard Practice.
- J. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the ENGINEER. This provision shall not apply to joints where waterstop is provided.
- K. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the WORK. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the ENGINEER.
- L. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

- M. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided during the placing of concrete.
- N. Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in concrete.
- O. **Cleaning:** The surfaces of metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

### 3.3 HANDLING, TRANSPORTING, AND PLACING

- A. **General:** Placing of concrete shall conform to the applicable portions of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.
- B. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.
- C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.
- D. **Placement in Wall and Column Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4-feet in walls and 8-feet in columns. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.
- E. **Conveyor Belts and Chutes:** Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR's conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.

F. **Placement in Slabs:** Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

G. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F. For sections less than 12-inches thick the temperature of concrete when placed shall be not less than 55 degrees.

1. If required by ENGINEER, CONTRACTOR shall submit detailed procedures for production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

2. CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

H. **Hot Weather Placement**

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.

2. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, CONTRACTOR shall employ effective means such as precooling of aggregates and using ice as mixing water or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.

3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

I. **Cold Weather Placement**

1. Placement of concrete shall conform to ACI 306.1 - Cold Weather Concreting, and the following.

2. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

4. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

J. **Underwater Placement**

1. Concrete deposited in water shall be designed for underwater placement with anti-washout admixtures. No concrete shall be placed in or under water unless otherwise permitted in writing by the ENGINEER.
2. To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump bucket, or other approved method, and shall not be disturbed after being deposited.
3. Concrete shall not be placed in running water. The forms for underwater concrete shall be constructed to provide static water within the forms. The concrete shall be placed continuously until the required depth is reached, keeping the surface of the concrete as nearly level as possible during placing.
4. If a tremie is used, the placing shall comply with the following requirements:
  - a. A tremie shall consist of a watertight tube having a diameter of not less than 10 inches with a hopper at the top. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering, when necessary to retard or stop the flow of the concrete. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall contain sufficient concrete to prevent water entry. When concrete is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end always keeping it in the deposited concrete.

### 3.4 PUMPING OF CONCRETE

- A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. **Pumping Equipment:** The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.
- C. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.
- D. Pumping equipment and hose conduits that are not functioning properly shall be replaced.
- E. Aluminum conduits for conveying the concrete shall not be permitted.
- F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

### 3.5 ORDER OF PLACING CONCRETE

- A. The order of placing concrete in the WORK shall be acceptable to the ENGINEER. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.
- B. The surface of the concrete shall be level whenever a run of concrete is stopped. For a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

### 3.6 TAMPING AND VIBRATING

- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.
- B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

### 3.7 FINISHING CONCRETE SURFACES

- A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and

dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. **Unformed Surfaces:** After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks. Fog nozzles are required for slabs containing silica fume admixtures. The classes of finish for unformed concrete surfaces are defined as follows:

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the ENGINEER.
3. Finish U3 - After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of irregularities.
4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.
5. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10	U4



percent	
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

### C. Floor Hardener (Surface Applied)

1. The following additional requirements apply to the substrate concrete in areas indicated to be under floor hardener:
  - a. Slump shall be no greater than 4-inches when peak ambient temperatures are expected to exceed 65 degrees F and no greater than 3-inches when temperatures will not exceed 65 degrees F.
  - b. Air content of the concrete shall not exceed 3 percent.
  - c. No calcium chloride or set accelerating admixture containing calcium chloride shall be used.
  - d. Do not use admixtures that increase bleeding.
  - e. Do not use fly ash.
2. The CONTRACTOR shall finish areas indicated to receive hardener in conformance with the manufacturer's recommendations and the following. After leveling the concrete surface and as soon as the concrete will support an operator and machine without disturbing the level or working up excessive fines, the CONTRACTOR shall float the surface of the slab with a mechanical float fitted with detachable shoes. Then apply 1/2 to 2/3 of the total amount of dry shake surface hardener uniformly to the surface. A mechanical spreader is recommended. Float the surface once the shake has absorbed sufficient moisture, as indicated by darkening of the shake. Immediately apply the remainder of the shake and allow it to absorb moisture. Do not apply shake when bleed water is present.
3. Perform a third floating if time and setting characteristics of the concrete will allow, but do not add water to the surface.
4. As the surface stiffens further and loses sheen, trowel with blades set relatively flat, using hand or mechanical methods. Remove marks and pinholes in a final raised trowel operation.
5. Cure the finished surface using the fill-forming curing compound recommended by the manufacturer at a coverage rate which will provide moisture retention in excess of the requirements of ASTM C 309. Maintain ambient temperatures above 50 degrees F during the curing period.

6. Keep floors covered and prohibit traffic and loads for 10 days minimum after completion.

### 3.8 CURING AND DAMPPROOFING

- A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and duct bank concrete and thrust blocks	3
Concrete surfaces not specifically indicated in this Paragraph	4
Floor slabs on grade in hydraulic structures	5
Slabs not on grade	6

- B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6 below.
- C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
- D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.
- E. **Method 4:** The surface shall be sprayed with a liquid curing compound.
1. Compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.
  2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet sandblasted to remove the curing compound.
5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.
6. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

**F. Method 5:**

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.
2. The curing blankets shall be left in place during the 7 Day curing period and shall not be removed until after concrete for adjacent WORK has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain concrete surfaces damp.

**G. Method 6:** This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.
  3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or any other causes. Edges shall be continuously held in place.
  4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
  5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.
  6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.
- H. **Method 7:** This method applies to concrete containing silica fume for walls and slabs and shall be used in addition to the curing methods 1 through 6 and shall be concluded within one hour of concrete placement.
1. In addition to the requirements of Method 1 for unstripped forms, Method 6 for walls after the forms are removed, and Method 4 for slabs, wall surfaces after the forms are removed and slab surfaces shall be coated with 2 coats of a white pigmented curing compound as indicated in Method 4 above. A second coat of white pigmented curing compound shall be applied to the concrete surface at 7 Days after the application of the initial coats. In addition, a prewetted burlap shall be placed over the flatwork surface and kept continuously wet for a minimum of 7 Days or until the time necessary to attain 70 percent of the required compressive strength in accordance with ACI 308 Section 3.1.3.
- I. **Dampproofing.** The exterior surfaces of roof slabs to be buried and walls to be backfilled shall be dampproofed as follows
1. Immediately after completion of curing the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon.
  2. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

### 3.9 PROTECTION

- A. The CONTRACTOR shall protect concrete against injury until final acceptance.
- B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

### 3.10 CURING IN COLD WEATHER

- A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing is temporarily discontinued.
- B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.
- C. Discontinuance of protection against freezing temperatures shall be such that the drop-in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.
- D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted.

### 3.11 TREATMENT OF SURFACE DEFECTS

- A. As soon as forms are removed, exposed surfaces shall be carefully examined, and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. Repairs and replacements shall be performed promptly.
- B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be

prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

- C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
- D. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

### 3.12 CARE AND REPAIR OF CONCRETE

- A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

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## SECTION 03 32 00 - JOINTS IN CONCRETE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.
- B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

#### 1.2 TYPES OF JOINTS

##### A. Construction Joints (CJ)

- 1. These joints are typically identified / abbreviated as "CJ" on the Contract Drawings.
- 2. The purpose of a construction joint is to bond concrete from an earlier pour to that of a later pour, and if in a water-bearing member, prevent water seepage at the joint location.
- 3. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.
- 4. Reinforcement typical to the slab exists across the joint.
- 5. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop of the type and shape indicated.

##### B. Contraction Joints (CRJ)

- 1. These joints are typically identified / abbreviated as "CRJ" on the Contract Drawings.
- 2. The purpose of a contraction joint is to de-bond concrete from an earlier pour to that of a later pour, and if in a water-bearing member, prevent water seepage at the joint location.
- 3. Contraction joints are similar to construction joints except that bonding is discouraged between the pours (chamfers, bond breaker),
- 4. Reinforcement typical to the slab does not pass through the joint. Sleeve-like dowels may exist across the joint, as indicated.
- 5. Waterstop shall be provided where indicated.

##### C. Expansion Joints (EJ)

- 1. These joints are typically identified / abbreviated as "EJ" on the Contract Drawings.



2. The purpose of an expansion joint is to allow concrete to expand freely as required, and if in a water-bearing member, prevent water seepage at the joint location.
3. In order to allow the concrete to expand freely, a space shall be provided between the pours. The space shall be obtained by placing a joint filler (premolded expansion joint material) against the earlier pour to act as a form for the later pour.
4. Reinforcement typical to the slab does not pass through the joint. Sleeve-like dowels may exist across the joint, as indicated.
5. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop of the shape indicated.

**D. Crack Control Joints (CCJ)**

1. These joints are typically identified / abbreviated as "CCJ" on the Contract Drawings.
2. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur, and if in a water-bearing member, prevent water seepage at the joint location. There are different alternatives that can achieve this goal. The alternative(s) selected for the WORK is (are) provided in the Contract Documents.
3. Reinforcement typical to the slab exists across the joint.
4. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop of the type and shape indicated.

**1.3 CONTRACTOR SUBMITTALS**

- A.** Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

**B. Shop Drawings**

1. Furnish placement drawings showing the location and types of joints for each structure.

**C. Manufacturer's Information and Certificates**

1. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:
  - a. **Waterstops.** Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.
  - b. preformed joint filler

- c. backing rod
  - d. bearing pad
  - e. slip dowels
2. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.
  3. Supplier certificates will not be accepted.

**D. Test Reports – Joint Sealant**

1. Furnish certified test reports from the joint sealant manufacturer on the actual batch of material supplied, demonstrating compliance with the indicated requirements.
2. Furnish the test reports before using the joint sealant on the Project.

**E. Samples**

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.
2. Such samples shall be extruded or molded sections of each size or shape to be installed.
3. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

**F. Welding Certification**

1. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.
2. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the ENGINEER, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

**1.4 QUALITY CONTROL**

**A. Waterstops**

**1. Inspections.**

- a. Waterstop field joints shall be subject to inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections.
- b. Provide not less than 24 hours notice for the scheduling of such inspections.

- c. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

**2. Sample Testing.**

- a. Field samples of prefabricated fittings (crosses, tees, and the like) may be selected at random by the ENGINEER for testing by a laboratory at the OWNER's expense.
- b. When tested, the tensile strength across the joints shall be at least 1,120 psi for PVC waterstops.

**3. Defects.** The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

- a. Offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- b. Exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- c. Any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less.
- d. Misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet.
- e. Porosity in the welded joint as evidenced by visual inspection.
- f. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)
- g. Visible signs of separation when the cooled splice is bent by hand at any sharp angle.
- h. Evidence of burned material.

**B. Joint Sealant**

**1. Test specimens.**

- a. The CONTRACTOR shall prepare adhesion and cohesion test specimens at intervals of 5 Days while joint sealants are being installed.
- b. The joint sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

- 1) Joint sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).
- 2) Spacing between the blocks shall be one inch.
- 3) Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold joint sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.
- 4) The joint sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.
- 5) Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

## 1.5 CORRECTION OF DEFECTS

- A. **Waterstops.** If inspections find waterstops to be defective, these joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.
- B. **Joint Sealant.** The CONTRACTOR shall furnish a 5-year written warranty of the entire joint sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the CONTRACTOR agrees to repair or replace, to the satisfaction of the OWNER, any defective areas which become evident within the 5-year period.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Joint materials shall be listed as compliant with NSF Standard 61.

### 2.2 WATERSTOPS

#### A. **PVC Waterstops**

1. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.
2. No reclaimed or scrap material shall be used.
3. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those indicated.

4. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2,000	D 638, Type IV
Ultimate Elongation-min, percent	350	D 638, Type IV
Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Accelerated Extraction (CRD-C572)		
Tensile Strength-min, psi	1,500	D 638, Type IV
Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalis (CRD-C572)		
Change in Weight, percent	plus 0.25/minus 0.10	-----
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1,400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

5. Flat strip and Center-Bulb Waterstops

- Flat strip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.
- The waterstop shall be provided with hog rings installed at 12 inches on centers along the waterstop.
- Shapes shall be as indicated, or as acceptable to the ENGINEER.

6. Retrofit Waterstops

- Retrofit waterstops and batten bars shall be as indicated or as acceptable to the ENGINEER.
- The waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

**B. Preformed Hydrophilic Waterstop**

1. Hydrophilic (bentonite-free) waterstops shall be **Sika Hydrotite CJ** manufactured by **Sika Corporation**, **Type NB190** manufactured by **JP Specialties**, or equal.
2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.
3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.
5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.
6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).
7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

**C. Waterproofing Tape**

1. Waterproofing tape waterstops shall be **Sikadur Combiflex SG** manufactured by **Sika Corporation** or approved equal.

**D. Other Waterstops**

1. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

**2.3 JOINT SEALER FOR NON-WATER-BEARING JOINTS**

- A. Joint sealer for non-waterstop joints in concrete shall be a material that is composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance that shall:
1. Not contain evaporating solvents, or volatile oils/lubricants;
  2. Strongly adhere to concrete surfaces;
  3. Remain permanently resilient and pliable;
  4. Not be affected by continuous presence of water;
  5. Not in any way contaminate potable water;
  6. Effectively seal the joints against moisture infiltration even when the joints are subjected to movement from expansion and contraction.

## 2.4 JOINT FILLER

- A. Joint filler for expansion joints in water holding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.
- B. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.
- C. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.
- D. **Neoprene Sponge.** The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

## 2.5 BACKING ROD

- A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.
- B. The rod material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.
- C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

## 2.6 BEARING PAD

- A. The bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness, unless otherwise indicated.

## 2.7 SLIP DOWELS

- A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

## 2.8 PVC TUBING

- A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

# PART 3 -- EXECUTION

## 3.1 GENERAL - WATERSTOPS

- A. Waterstops shall be embedded in the concrete across joints as indicated.
- B. Waterstops shall be fully continuous for the extent of the joint.

- C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.
- D. The CONTRACTOR shall take suitable precautions and provide means to support and protect the waterstops during the progress of the WORK and shall repair or replace any waterstops damaged during progress of the WORK at no additional cost to the OWNER.
- E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.
- F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

### 3.2 SPLICES IN PVC WATERSTOPS

- A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.
- B. It is essential that:
  - 1. The material shall not be damaged by heat sealing.
  - 2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.
  - 3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.
  - 4. No edge welding will be accepted.
- C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
- D. Other Joints
  - 1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint.
  - 2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.
- E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.



### 3.3 JOINT CONSTRUCTION

#### A. **Setting Waterstops**

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.
2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the WORK and to ensure proper embedment in the concrete.
3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.
4. The center axis of the waterstops shall be coincident with the joint openings.
5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

#### B. **Waterstop Placement**

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.
2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel.
3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.
4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.
5. In placing center-bulb waterstops in expansion joints, the center-bulb shall be centered on the joint filler material.
6. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

#### C. **Joint Location**

1. Construction joints and other types of joints shall be provided where indicated.
2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.
3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.
4. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

#### **D. Joint Preparation**

1. **Construction Joints:** The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum of 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed. The following is also required:
  - a. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.
  - b. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.
2. **Old Concrete:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the OWNER. This provision shall not apply to joints where waterstop is provided.

#### **E. Retrofit Waterstops**

1. **Joint Preparation**
  - a. Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material.
  - b. The surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to the application of epoxy and waterstop.
2. Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless steel anchors at 6 inches on-center, staggered, and in accordance with the manufacturer's written recommendations.

#### **F. Joint Sealant**

1. Crack control joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a joint sealant, as indicated.
2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.
3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.

4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter, they shall be primed and filled with the construction joint sealant.
5. No joint sealant shall be used without a primer. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.
6. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the joint sealant.
7. Care shall be used to completely fill the sealant grooves.
8. The joint sealant shall be installed by a competent waterproofing specialty contractor with a successful record of performance in similar installations.
9. The joint sealant shall achieve final cure at least 7 Days before the structure is filled with water.

**10. Mixing**

- a. Catalyst-cured, 2-part materials shall be thoroughly, and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.
- b. Before any sealer is placed, the CONTRACTOR shall arrange to have workers performing the WORK carefully instructed on the proper method of mixing and application by a representative of the joint sealant manufacturer.

**11. Failure to Cure**

- a. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.
- b. The groove shall be re-sealed with the indicated joint sealant.
- c. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR's responsibility as part of the WORK.

**G. Hydrophilic Waterstop**

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.
2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.
3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.

4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.
5. **Location**
  - a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.
  - b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.
6. **Placement**
  - a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.
  - b. The groove shall be at least 3/4-inch-deep and 1-1/4 inches wide.
  - c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.
7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.
8. The hydrophilic waterstop shall not be installed where the air temperature falls below the manufacturer's recommended range.
9. **Preparation**
  - a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.
  - b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.
  - c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.
10. **Securing**
  - a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.
  - b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

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## SECTION 03 60 00 - GROUT

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents
- B. **Grout Types.** The following types of grout are covered in this Section:
  - 1. Non-Shrink Grout - Class I (cement-based)
  - 2. Non-Shrink Grout - Class II (cement-based)

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

#### 1.3 QUALITY CONTROL

##### A. **Field Tests**

- 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.
- 2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 -

Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 30 00 - Cast-in-Place Concrete, at intervals during construction selected by the ENGINEER.
  4. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
  5. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.
- B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete, unless indicated otherwise.

C. **Pre-Installation Demonstration and Training**

1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. **Manufacturer's Warranty**

1. Furnish one-year warranty for WORK provided under this section.
2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

**PART 2 -- PRODUCTS**

2.1 APPLICATION

- A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts and reinforcing steel required to be set in grout that is not in high temperature or high fire risk areas.	Epoxy Anchor Grout (See Spec 03 65 00)
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink - Class I
Storage tanks and other non-motorized equipment and machinery under 30 horsepower	Non-Shrink - Class I

Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink - Class I (Class II where placement time exceeds 20 min.)
Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material	Non-Shrink - Class I
Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials	Non-Shrink - Class II
Any application not listed above, where grout is indicated	Non-Shrink Class I, unless specifically indicated otherwise

## 2.2 CEMENT GROUT

- A. Cement grout shall be composed of one-part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4,000 psi.
- B. Cement grout materials shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete.

## 2.3 NON-SHRINK GROUTS (Cement-based)

### A. General

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:
  - a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.



- b. Minimum flexural strength of 1,000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- c. Minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
- d. Grout shall be certified for use in freeze/thaw environments.

**B. Class I Non-Shrink Grout**

- 1. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency.
- 2. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
- 3. Grout shall have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures. The grout when tested shall not bleed or segregate at maximum allowed water.
- 4. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
- 5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
- 6. Class I Non-Shrink Grout shall be **MasterFlow 713** by **BASF**, **Five Star Grout** by **Five Star Products**, **SikagROUT 212** by **Sika Corporation**, **L&M CRYSTEX** by **Laticrete**; **Hi-Flow Grout** by **Euclid Chemical Company** or approved equal.

**C. Class II Non-Shrink Grout**

- 1. Class II non-shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-Day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.
- 2. Grout shall have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.
- 3. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
- 4. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.

5. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
6. The grout when tested shall not bleed or segregate at maximum allowed water content.
7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
8. Class II non-shrink grout shall be **MasterFlow 928** by **BASF**, **Five Star Fluid Grout 100** by **Five Star Products**, **L&M CRYSTEX** by **Laticrete**, or approved equal.

## 2.4 CURING MATERIALS

- A. Curing materials shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete and as recommended by the manufacturer of prepackaged grouts.

## 2.5 CONSISTENCY

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.
- B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

## 2.6 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

# PART 3 -- EXECUTION

## 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

## 3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

- C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

### 3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. **Equipment, Tank, and Pipe Supports.** Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.
  - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
  - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted for acceptance by the ENGINEER.
  - 3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

#### C. **Drilled Anchors and Reinforcing Bars**

- 1. General
  - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a

power drill and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

- b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

## 2. Cement Based Non-Shrink Grout

- a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.
- b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
- c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one inch, the hole diameter should be at least twice the bolt diameter.
- d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
- e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

## 3.4 CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

## 3.5 CURING

- A. Cement based grouts shall be cured per Section 03 30 00 - Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -

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## SECTION 03 65 00 - EPOXY RESIN ADHESIVE SYSTEMS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide epoxy resin adhesives, complete and in place, in accordance with the Contract Documents
- B. **Epoxy Resin Adhesives Types.** The following types of epoxy resin adhesives are covered in this Section:
  - 1. Epoxy Anchor Resins for Adhesive Anchors

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certification that resins used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of resin used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor resin for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink resin does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of resin manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated resins.

#### 1.3 QUALITY CONTROL

##### A. Field Tests

- 1. Compression test specimens will be taken from the first placement of each type of resin, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.
- 2. Compression tests and fabrication of specimens for epoxy resins will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes,

Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

3. The cost of laboratory tests on resin will be paid by the OWNER except where test results show the resin to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
4. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 33 00 - Cast-in-Place Concrete, unless indicated otherwise.

C. **Pre-Installation Demonstration and Training**

1. **Epoxy Anchor Resins for Adhesive Anchors**

- a. Special inspection as recommended by the ICBO/ES report or as required by the building department shall be required for adhesive anchor installations. Cost of special inspection of adhesive anchors will be paid by the OWNER.
- b. Before installing adhesive anchors in the WORK, adhesive anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:
  - 1) Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading/torquing.
  - 2) Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension and shear loading. A minimum of 3 anchors shall be tested for each installation position.
  - 3) Anchors shall be tested at 2 times the published allowable load in tension and in shear as indicated in the ICBO/ES report.
  - 4) If any of the 3 test bolts in any installation position fail to reach the test loads, the installer shall be re-tested with the same procedure. Re-testing is required only for the failed installation position.
  - 5) An installer who has 3 consecutive successful bolt tests in the first or second trial is considered qualified for adhesive anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the CONTRACTOR and be submitted to the ENGINEER.

- 6) The test anchor size shall be the largest size adhesive anchor used on the project. The embedment length shall be long enough to develop the allowable steel strength per AISC Manual of Steel Construction.
- 7) Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.
- 8) The certification of each qualified installer shall be available for verification at the Special Inspector's request.
- 9) Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

#### 1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

##### A. **Manufacturer's Warranty**

1. Furnish one-year warranty for WORK provided under this section.
2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

## **PART 2 -- PRODUCTS**

### 2.1 APPLICATION

- A. Unless indicated otherwise, epoxy adhesive resins shall be provided as listed below whether indicated on the Drawings or not.

<b>Application</b>	<b>Type of Epoxy Resins</b>
Anchor bolts and reinforcing steel required to be set in resin that is not in high temperature or high fire risk areas.	Epoxy Anchor Resin

### 2.2 EPOXY ANCHOR RESIN

- A. Epoxy anchor resin shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class A, B and C B & C, Grade 3 with the exception of gel time.
- B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.
- C. Manufacturer shall certify that the epoxy anchor resin will maintain 90 percent of its strength up to a temperature of 125 degrees F.
- D. Resin shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The resin shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.



- E. Epoxy anchor resin shall be capable of being used in submersed applications once cured.
- F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
- G. Whenever possible, overhead anchors subject to vibration, anchors in fire-resistive construction or high fire risk areas, and anchors subject to working or operating temperatures above 100 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink resin and oversized holes.
- H. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.
- I. Epoxy anchor resin shall be **HIT-RE 500 V3** by **Hilti** or approved equal.

## 2.3 CURING MATERIALS

- A. Curing materials shall be in accordance with recommendations by the manufacturer of prepackaged resins.

## 2.4 CONSISTENCY

- A. The consistency of resins shall be that necessary to completely fill the space to be resined for the particular application. Dry pack consistency is defined such that the resin is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a resin of that consistency; the type of resin to be used shall be as indicated herein for the particular application.
- B. The slump for topping resin and concrete/resin fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

## 2.5 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement resin shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged resins shall have ingredients measured by means recommended by the manufacturer.

# PART 3 -- EXECUTION

## 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Resin shall be stored in accordance with manufacturer's recommendations.

## 3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged resins to provide on-Site technical assistance within 72 hours of request, as part of the WORK.

- B. Resin shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- C. Concrete substrate shall not be wet prior to placement of epoxy resins.
- D. The finish of the resin surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with resin shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after resining.
- G. Contact the resin manufacturer's representative for assistance on hot and cold weather resining techniques and precautions if applicable.

### 3.3 RESINING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged resins shall be done according to the instructions and recommendations of the manufacturer.
- B. **Equipment, Tank, and Pipe Supports.** Structural, equipment, tank, and piping support bases shall be resined, unless indicated otherwise.
  - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of resin or other thickness if indicated.
  - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type resin through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for resin shall be tight against retaining surfaces, and joints shall be sealed as recommended by the resin manufacturer to be liquid-tight. Forms shall be coated as recommended by the resin manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate resining methods shall be submitted for acceptance by the ENGINEER.
  - 3. Concrete equipment pads for equipment bases that will be epoxy-resined shall be sized so that, when the equipment base is fully resined, the epoxy resin is stopped not less than 4-inches from the edge of the pad.
- C. **Drilled Anchors and Reinforcing Bars**
  - 1. General
    - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill and cleaned. Drilled anchors shall not be installed until the concrete

has reached the required 28 Day compressive strength. Anchors shall not be loaded until the resin has reached its indicated strength in accordance with the manufacturer's instructions.

- b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

## 2. Epoxy Adhesive Anchors

- a. Resin shall be proportioned and mixed with automatic equipment.
- b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.
- c. Holes shall be dry.

## 3.4 CONSOLIDATION

- A. Resin shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be resined is completely filled.

## 3.5 CURING

- A. Cement based resins shall be cured per Section 03 30 00 - Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -

## SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

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

- A. References herein to "Building Code" shall mean the International Building Code (IBC). The edition of the codes adopted as of the date of award of this contract shall apply to the WORK herein.

- B. Federal Specifications and Commercial Standards

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
AISC DG 27	Structural Stainless Steel
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A 312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105-ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 588	Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
AWS D1.1	Structural Welding Code – Steel
AWS D1.6	Structural Welding Code – Stainless Steel

### 1.3 CONTRACTOR SUBMITTALS

- A. Submit in accordance with Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.
- C. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the ENGINEER with copies to the CONTRACTOR and others as required.

## PART 2 -- PRODUCTS

### 2.1 MATERIALS

- A. Structural steel framing for pre-engineered metal building shall be in accordance with requirements of Specification 13 34 19.
- B. **Weathering steel (Chinook Raceways Predator Netting Framing)**

Wide flanges & other shapes, plates, and bars	ASTM A588, GR. 50
Bolts	ASTM F3125, GR. A325 Type 3
Nuts	ASTM A563, Gr. DH3
Washers	ASTM F436, Type 3

C. **Mild Painted Steel (Coho and Chinook Incubation Stack Frames, Coho Head Tank Frame)**

Wide flanges	ASTM A992, GR. 50
Other shapes, plates, and bars	ASTM A36
Pipe	ASTM A53
Hollow Structural Sections	ASTM A500, GR. B

D. **Stainless steel**

Plates	ASTM A240, Type S31600
Bars and Shapes	ASTM A276, Type S31600
HSS	ASTM A312, Type S31600

- E. Bolts for connections shall be ASTM A 193 and A 194, Type 316 stainless steel, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A 193 and A 194, Type 316 stainless steel.
- F. Anchor bolts for primary building column base plates shall be ASTM F593, Type 316 Stainless Steel unless indicated otherwise.
- G. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by **Nelson Stud Welding Company (Stanley)** or equal.
- H. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the ENGINEER.

2.2 INSPECTION AND TESTING

- A. Shop inspection may be undertaken by the OWNER at its own expense. The CONTRACTOR shall give ample notice to the ENGINEER prior to the beginning of any fabrication so that inspection may be provided. The CONTRACTOR shall furnish facilities for the inspection of materials and workmanship in the shop, and inspectors shall be allowed free access to the necessary parts of the WORK. Inspectors shall have the authority to reject any materials or WORK that does not meet requirements. Inspection at the shop is intended as a means of facilitating the WORK and avoiding errors, but it is expressly understood that it will in no way relieve the CONTRACTOR from responsibility for proper materials or workmanship under this Specification.
- B. The OWNER may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.

1. Ten percent of all butt and bevel welds which extend continuously for 24-inches or less may be completely tested in accordance with AWS D1.6, Part E, Radiographic Testing of Welds, Chapter 6. Butt and bevel welds that extend continuously for more than 24-inches will be spot tested at intervals not exceeding 36-inches.
  2. Defective welds shall be corrected or redone and retested at the CONTRACTOR's expense and to the satisfaction of the welding inspector.
  3. The CONTRACTOR shall test to failure 3 bolts from each heat lot of bolts furnished to the job to verify compliance with this Specification. The testing laboratory shall be approved by the ENGINEER, and test reports shall be furnished to the ENGINEER in accordance with Section 01 33 00.
- C. The costs for initial testing will be paid by the OWNER. However, the CONTRACTOR shall pay testing costs for any additional testing and investigation on WORK that proves to be defective. The CONTRACTOR shall supply material for testing at no cost to the OWNER and shall assist the ENGINEER in obtaining material for test samples.

## **PART 3 -- EXECUTION**

### **3.1 MEASUREMENT**

- A. The CONTRACTOR shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of WORK. The CONTRACTOR shall review the Drawings, and any discrepancies shall be reported to the ENGINEER for clarification prior to starting fabrication.

### **3.2 FABRICATION**

- A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and the Shop Drawings.
- B. Materials shall be properly marked and match-marked for field assembly.
- C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

### **3.3 CONNECTIONS**

- A. Shop and field connections shall be bolted or welded as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.
- B. Unless otherwise indicated, welds shall conform to AISC LRFD Specification for Structural Steel Buildings.

### **3.4 WELDED CONSTRUCTION**

- A. The CONTRACTOR shall comply with the current AWS D1.1 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting Defective WORK. Welded architectural metal that is exposed to view shall have welds ground

smooth. Shielded metal arc welding method or gas metal arc welding methods shall be used for welding structural steel.

- B. Unless otherwise indicated, butt and bevel welds shall be complete penetration.

### 3.5 HOLES FOR OTHER WORK

- A. Holes shall be provided as necessary or as indicated for securing other WORK to structural steel framing, and for the passage of other WORK through steel framing members. No torch cut holes will be permitted.

### 3.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.
- B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

### 3.7 ERECTION

- A. The CONTRACTOR shall comply with the AISC Specifications and Code of Standard Practice, and with indicated requirements.
- B. Anchor bolts and other connectors required for securing structural steel to in-place WORK and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the CONTRACTOR.
- C. The CONTRACTOR shall be responsible for designing and installing any temporary bracing required for the safe erection of structural steel members.

### 3.8 SETTING BASES AND BEARING PLATES

- A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and masonry bearing surface shall also be cleaned of all bond-reducing materials and be roughened to improve bonding.
- B. Loose and attached baseplates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.
- C. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its indicated strength.
- D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.



### 3.9 FIELD ASSEMBLY

- A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.
- B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.
- C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

### 3.10 MISFITS AT BOLTED CONNECTIONS

- A. Where misfits in bolting are encountered, the ENGINEER shall be immediately notified. The CONTRACTOR shall submit a method to remedy the misfit for review by the ENGINEER. The ENGINEER will determine whether the remedy is acceptable or if the member must be refabricated.
- B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.
- C. Correction of misfits is part of the WORK.

### 3.11 GAS CUTTING

- A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the ENGINEER. Gas-cut sections shall be finished equal to a sheared appearance.

- END OF SECTION -

## SECTION 05 50 00 - MISCELLANEOUS METALWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

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

##### A. Federal Specifications

MIL-G-18015 A (3) (Ships) Aluminum Planks. (6063-T6)

MIL-A-907E Antiseize Thread Compound, High Temperature

##### B. Codes

OSHA 1927.10 Fixed Ladders

##### C. Commercial Standards

AA-M32C22A41 Aluminum Assn.

AASHTO HS-20 Truck Loading

AISC Manual of Steel Construction

AISI Design of Light Gauge, Cold-Formed Steel Structural Members

ANSI / AWS D1.1 Structural Welding Code - Steel

ANSI / AWS D1.2 Structural Welding Code - Aluminum

ANSI / AWS QC1 Qualification and Certification of Welding Inspectors

ASTM A 36 Carbon Structural Steel

ASTM A 48 Gray Iron Castings

ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 193 Alloy-Steel and Stainless-Steel Bolting Materials for High Temperature Service

ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing

### 1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

#### B. **Shop Drawings**

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.
2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.
3. Anchors
  - a. Submit an ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor.
  - b. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors.
  - c. Upon review by the ENGINEER, these instructions shall be followed specifically.
  - d. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

### 1.4 QUALITY CONTROL

- A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.
- B. Welding shall be inspected by a CONTRACTOR-furnished inspector qualified in accordance with AWS requirements and approved by the ENGINEER.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

#### **A. Aluminum**

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.
2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 96 00 - Protective Coatings.

#### **B. Stainless Steel**

1. Unless otherwise indicated, stainless steel metalwork shall be fabricated from Type 316 stainless steel.
2. Unless otherwise indicated, stainless steel bolts and anchors shall be fabricated from materials indicated in section 2.3 BOLTS AND ANCHORS of this specification.

### **2.2 HATCHES**

- A. Hatches shall be in accordance with Specification 07 72 33.

### **2.3 BOLTS AND ANCHORS**

#### **A. Standard Service**

1. Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be fabricated from 316 stainless steel as indicated.
2. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following requirements:
  - a. Structural Connections: ASTM F593, Type 316
  - b. Anchor Bolts: ASTM F593, Type 316
  - c. Pipe and Equipment Flange Bolts/Nuts: ASTM A 193/A 194, Grade B-7

#### **B. Anti-seize Lubricant Coating**

1. Threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless-steel bolts, meeting government specification MIL-A-907E.
2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology**, Franklin Park, IL, 60131, or equal.

**C. Bolt Requirements**

1. The bolt and nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts.
3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.
6. Lock washers fabricated from material matching the bolts shall be installed where indicated.
7. The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

**2.4 Drilled Anchors in Concrete and Masonry**

**A. General**

1. Unless otherwise indicated, drilled concrete or masonry anchors shall be epoxy adhesive anchors in accordance with Specification 03 65 00 – Epoxy Resin Adhesive Systems.
  - a. No substitutions will be considered unless accompanied with an ICBO report verifying strength and material equivalency.
2. Expanding type anchors are not permitted unless specifically indicated otherwise in the Contract Documents.

**PART 3 -- EXECUTION**

**3.1 FABRICATION AND INSTALLATION REQUIREMENTS**

**A. Fabrication and Erection**

1. Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

## 3.2 WELDING

### A. Methods & Qualifications

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.
2. The qualification of the welders shall be in accordance with the AWS Standards.

### B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.
2. Weld reinforcement shall be as indicated by the AWS Code.
3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.
5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

## 3.3 DRILLED ANCHORS

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.
- C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- END OF SECTION -

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## SECTION 06 82 00 - FIBER REINFORCED PLASTIC FABRICATIONS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide fabricated fiberglass reinforced plastic (FRP) items, complete and in place, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals
  - B. **Shop Drawings:** Shop Drawings for every FRP item. Include plans, elevations, and profiles that clearly show material sizes, types, styles, part or catalog numbers. Drawings shall include complete details for the fabrication and erection of components, including location, dimensions, lengths, joining method, type and size of fasteners, clip angles, member sizes, and connection details.
  - C. Layout drawings for grating shall show the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.
    - 1. Submit load and deflection tables for each style and depth of grating used.
  - D. **Product Literature:** Manufacturer's published literature including structural design data, structural properties, and load and deflection tables for each style and depth of grating, corrosion resistance tables, certificates of compliance, test reports (as applicable), anchoring system allowable load tables and ICBO reports.
  - E. **Calculations:** Structural calculations shall be submitted for stairs, stair support systems, handrails, railing systems, brackets, support flanges, ladders, and fasteners or anchors. Calculations shall be signed and sealed by a profession engineer registered in the State of California.
  - F. **Samples:** Samples of each type of product shall be submitted if requested by the ENGINEER.
  - G. **Certification:** The CONTRACTOR shall certify on the Shop Drawings that items and fabrications have been manufactured of materials suitable for potable water usage per NSF 61, and that fabricated items are of sufficient strength to serve their intended function without undue distortion or deflection.
- #### 1.3 QUALITY CONTROL
- A. **Manufacturer's Qualifications:** Items provided under this Section shall be furnished only by manufacturers having experience in the manufacture of similar products, with a record of five (5) similar successful installations in the last five (5) years.



- B. **Quality:** Fiberglass items shall be constructed of new, first-class, commercial-quality, fiberglass fabric-reinforced polyester or vinyl ester resin laminate material of the strength, thickness, and dimensions indicated, using the matched die-molded method.

## PART 2 -- PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. FRP items shall be composed of fiberglass reinforcement and resin in quantities, qualities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions indicated.
- B. Fiberglass reinforcement shall be continuous roving, continuous strand mat, and surfacing veil or a combination thereof in sufficient quantities for the application and physical properties required.
- C. Unless indicated otherwise, resin shall be fire retardant isophthalic polyester or vinyl ester with chemical formulation as necessary to provide the corrosion resistance, strength, and other physical properties as required.
- D. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids, and without dry spots, cracks, crazes, or unreinforced areas. Glass fibers shall be well covered with resin to protect against exposure from wear or weathering.
- E. Resin shall include an ultraviolet (UV) inhibitor additive. FRP products located in exterior locations exposed to the weather or in UV facilities shall also have an additional 1-mil UV-resistant coating applied.
- F. FRP products shall have a tested flame spread rating of 25 or less per ASTM E 84 - Surface Burning Characteristics of Building Materials. Gratings and stair treads shall also meet the self-extinguishing requirements of ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
- G. **Supports and Fasteners:** The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the WORK of this Section in accordance with the requirements of the manufacturers of the items. Bolts, anchor bolts, washers, and supports shall be Type 316 stainless steel. Concrete anchor systems shall be in accordance with Section 03 65 00 – Epoxy Resin Adhesive Systems.
- H. Cut or machined edges, holes, scratches, gouges, and abrasions shall be sealed with a resin compatible with the resin matrix used in the original item.

### 2.2 FIBERGLASS GRATING

- A. General
1. **Seat Angles:** Where grating is supported on concrete members, continuous embedded seat angles shall be provided on all sides. Grating seat angles shall be made of stainless steel and be as detailed on the Drawings.

2. **Load/Deflection Requirements:** Grating shall be capable of spanning the distances indicated with a minimum safety factor of 3 for stresses and without exceeding a deflection equal to the lesser of 1/4-inch or the span divided by 180. The loading used for determining stresses and deflections shall be the uniform live load of the adjacent floor area or 100 pounds per square foot, whichever is greater, or a concentrated load of 1,000 pounds at the center of the span, unless otherwise indicated.
3. **Color:** The color of the grating shall match. The color shall be gray. The color selected shall result in no additional cost to the OWNER.
4. The top surface of grating shall be provided with a non-slip surface by embedding or bonding grit to the FRP.
5. **Penetrations:** Cutouts shall be provided where needed for penetrations through the grating. The grating shall be reinforced where necessary to meet the load/deflection requirements despite the cutouts.
6. **Dimensional Requirements:** When grating is designed to span primarily in one direction, the grating shall be fabricated to span in the shorter span direction, unless indicated otherwise. Individual pieces of grating shall not exceed 80 pounds in weight, unless indicated otherwise.
7. Mechanical grating clips shall be manufactured of Type 316 stainless steel. Grating hold-down clips shall be provided, spaced at a maximum of 4-feet apart or as recommended by the manufacturer, whichever is less. A minimum of 4 clips per piece of grating is required.

## 2.3 MOLDED FRP GRATING

- A. Molded FRP grating shall be of a one-piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern.
- B. Gratings shall be reinforced with continuous rovings of equal number of layers in each direction to provide bidirectional load bearing.
- C. **Non-slip surfacing:** Grating shall have grit on the top of each bar for maximum slip resistance.
- D. Load/Deflection: Grating shall meet manufacturers published safe recommended loadings with deflection not to exceed the following:
  1. Uniform distributed load over a 36" span: 100 pounds per square foot, with a maximum deflection of 0.25".
- E. Molded FRP grating shall be **Fibergate** by **Fibergate Composite Structures, Inc.**, or equal.
- F. Resin system: The resin system used in the manufacture of the grating shall be ISOFR. Manufacturer may be required to submit corrosion data from tests performed on actual

grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.

## 2.4 POLTRUDED FRP GRATING

- A. Grating components shall be high strength and high stiffness pultruded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two piece cross rod system to provide a mechanical and chemical lock. Cross rods should be below the walking surface of the grating. Gratings with cross rods that are flush with the walking surface are excluded.
- B. Non-slip surfacing: Grating shall be provided with a quartz grit bonded and baked to the top surface of the finished grating product.
- C. Fire rating: Grating shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Manufacturer may be required to provide certification of ASTM E84 test on grating panels from an independent testing laboratory. Test data shall be from full scale testing of actual production grating, of the same type and material supplied on the project. Test data performed only on the base resin shall not be acceptable.
- D. Resin system: The resin system used in the manufacture of the grating shall be ISOFR. Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.
- E. Color: Gray.
- F. Depth: 1-1/2" deep load bars with a tolerance of plus or minus 1/32".
- G. Mesh Configuration: 1-1/2" load bar spacing, 6" tie bar spacing on centers. Grating shall be SAFE-T-SPAN® I5015V or I5015I as manufactured by Fibergrate Composite Structures Incorporated, or approved equal.
- H. Load/Deflection: Grating shall meet manufacturers published safe recommended loadings with deflection not to exceed the following:
  - 1. Uniform distributed load over a 60" span: 100 pounds per square foot, with a maximum deflection of 0.25".
- I. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

## 2.5 FRP STAIR TREADS

- A. Stair treads shall be of a one-piece molded construction reinforced with continuous rovings.
- B. **Non-slip surfacing:** Stair treads shall be manufactured with either a concave profile on the top of each bar or shall have grit bonded or embedded to provide maximum slip resistance. For additional safety and to meet OSHA requirements, stair treads shall be manufactured with a minimum 1.5-inch molded nosing. Nosing shall be bonded with angular grit.
- C. **Load/Deflection Criterion:** Stair treads shall be within allowable stress levels and shall not exceed a deflection of 1/4-inch or the span divided by 180, whichever is less. The loading to be used for determining stresses and deflections shall be a uniform live load of 100 psf or a concentrated load of 300 pounds at the center of the span.
- D. **Hardware:** Type 316 stainless steel hold-down clips shall be provided, spaced as recommended by the manufacturer. A minimum of four hold-down clips shall be required for each tread.
- E. FRP stair treads shall be **Fibertred** by **Fibergrate Composite Structures, Inc.**, or equal.
- F. Stair stringers and miscellaneous steel connection plates shall be Type 316 stainless steel

## 2.6 RAILINGS

- A. Posts and rails shall be structural shapes manufactured by the pultrusion process.
- B. Handrails that are used in industrial-commercial, non-public areas shall be a 3-rail system with equal open spaces between rails and toeboard with no open space larger than 12-inches as required by the OSHA.
- C. Posts shall be not less than 2-inches square for square systems or 1.9-inches diameter for round rail systems. Rails and railings shall be not less than 1.5-inch square for square rail systems or 1.9-inches diameter for round rail systems and shall be provided with bottom enclosures. Top railings shall be as long as possible and the posts shall not project through the top rails.
- D. The minimum mechanical properties for structural shapes used in the handrail shall be as required for structural shapes below.
- E. **Color:** Rails, posts, and kick plates shall be integrally pigmented yellow.
- F. **Loading Conditions:** Railings and handrail brackets shall be capable of withstanding the following non-simultaneous loading conditions without exceeding the allowable working stress of the material and without permanent deformation, with a minimum factor of safety on loading of 2.0.

1. A 200-pound concentrated load applied to any point in any direction
  2. A 50 pound per linear foot loading applied perpendicular to the top rail.
- G. The post/rail connection shall be fabricated such that the rails are unbroken and continuous through the post without the use of packs or splices. Exposed post corners shall be radiused to eliminate sharp edges. The rails shall be joined to the post through a combination of bonding and mechanical fastening. No sharp or protruding edges shall remain after assembly of the railing. Spacing of the posts shall not exceed 6-feet for straight runs or 4-feet for inclined runs.
- H. The base of the posts shall be reinforced to a minimum height of 1-inch above the uppermost bolt hole.
- I. Full posts shall be located not more than 18-inches from horizontal or vertical change in railing direction.
- J. **Hardware:** Fasteners in the railing system shall be Type 316 stainless steel.
- K. FRP handrail shall be **Dynaround** by **Fibergrate Composite Structures, Inc.**, or equal.

## 2.7 LADDERS

- A. Ladder side rails, rungs, ladder mounting brackets, and cage straps shall be FRP structural shapes manufactured by the pultrusion process. The minimum mechanical properties for structural shapes used in ladders and cages shall be as required for structural shapes below. Cage hoops and brackets shall be produced by the open molded hand lay-up method.
- B. Wall brackets connecting the ladder to the wall shall be spaced at a maximum of 6-feet on centers.
- C. Rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both chemical and mechanical fastenings.
- D. **Non-slip surfacing:** Ladder rungs shall be provided with either continuous flutes around the rung or a quartz grit integrally molded into the top surface of the rung.
- E. **Color:** Ladder and cage components shall be integrally pigmented yellow. Wall and floor mount brackets shall be gray.
- F. **Loading Criterion:** The completed ladder and cage installation shall meet the load requirements as set forth in OSHA 1910 (latest edition) with a minimum factor of safety on loading of 2.0. The ladder shall also be capable of supporting an ultimate concentrated vertical load of 1,200 pounds applied at the mid-span of the rung. The ladder manufacturer shall be required to provide supporting test data for rung capacity.
- G. FRP ladders shall be **Dynarail Ladders** by **Fibergrate Composite Structures, Inc.**, or approved equal.

## PART 3 -- EXECUTION

### 3.1 PRODUCT DELIVERY AND STORAGE

- A. **Delivery of Materials:** Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins, catalysts, and hardeners shall be crated or boxed separately.
- B. **Storage of Products:** Materials shall be carefully handled to protect them from abrasion, cracking, chipping, twisting, deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins, catalysts, and hardeners in dry indoor storage facilities between 70- and 85-degrees F (21 to 29 degrees C). There shall be labels on the outside of the boxes indicating that the products shall be stored as described above.

### 3.2 GENERAL

- A. FRP products shall meet the dimensional requirements and tolerances indicated. The CONTRACTOR shall verify measurements and determine correct size and locations of required holes or cutouts from field dimensions before fabrication.
- B. FRP products shall be fabricated free from warps, twists, or other defects that affect appearance and serviceability.
- C. The CONTRACTOR shall give ample notice prior to the beginning of any fabrication work so that the ENGINEER can perform shop inspections.
- D. The CONTRACTOR shall install FRP structures in accordance with the manufacturer's assembly drawings. Field cut and drill FRP products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products.
- E. Bonding of FRP items shall be through the use of an epoxy adhesive recommended by the manufacturer of the particular item. The surfaces to be bonded shall be solvent cleaned and abraded sufficiently to remove the surface gloss and to remove any mold release agent or other contaminants which may interfere with proper bonding. The adhesive manufacturer's instructions and recommendations shall be followed. The items bonded shall not be stressed until at least 48 hours have passed.

### 3.3 GRATING

- A. **Layout:** Each grating section shall be readily removable except where indicated. As much as possible, manufacturer shall provide openings and holes where indicated on the Contract Drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

1. Install the grating with a minimum 1.5-inch bearing surface at the support ends.

2. Tolerances between sections shall provide for not more than 1/4-inch clearance between adjacent sections or between grating and frames. Adjacent sections shall line up to form an uninterrupted straight line where possible.
3. The grating shall be as free, as commercially possible from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits. The surface shall have a smooth finish (except for non-slip surfaces).
4. Seat angles shall be mitered and bonded at corners to produce smooth, even, level seating surface.
5. Grating shall be installed so that the top surface is level and even with adjacent walking surfaces. There shall be no protrusions above the top surface.
6. Grating shall be fastened to supports.

### 3.4 LADDERS

- A. Ladders shall be fully shop assembled.

### 3.5 RAILINGS

#### A. **Component Systems**

1. Unless otherwise indicated, handrails and railings shall be component systems, complete and ready for use with anchors, attachments, pickets, brackets, caps, fasteners, gates, posts, sleeves, trim, and all other related items required or necessary for the complete installation.
2. Installation instructions, splice fasteners, and adhesive shall be included in each shipment. Handrails shall have cut edges sealed. The handrail will be shipped prefabricated, requiring only post, kick plate, and rail splicing.

- B. **Workmanship:** Work shall be performed by craftsmen experienced in the fabrication of structural fiberglass items. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field in advance. Joints, junctions, miters, and butting sections shall be precision-fitted, with no gaps occurring between sections, and surfaces shall be flush and aligned.

- C. **Alignment:** Pultruded, case-molded, or bent work shall be straight and with true edges. Railings and handrails shall be provided with continuous top rails, without post projections or other obstructions.

- D. **Expansion/Contractions:** Exterior railing systems shall provide for 1/4-inch expansion and contraction per 20 linear feet of railing. Interior railing systems shall provide for 1/8-inch expansion or contraction per 20 linear feet of railing.

- E. **Railing Continuity and End Treatment:** Handrails and railings shall be designed to form a continuous run system with elbow turns and bends that do not interfere with hand movement. Handrails shall be continuous for the full length of the stairs and landings. Handrails shall extend not less than 12-inches beyond the top and bottom risers. Ends

of handrails shall be returned to wall or shall be terminated in newel posts or safety terminals. Newel posts and safety terminals may be used only when approved by the ENGINEER.

**F. Gates and Removable Sections**

1. Gates shall be provided with self-closing hinges and self-closing latch bolts. Removable handrail sections shall be provided where indicated. The gate and removable railing hardware color shall match that of the railing system of which it is a part.
2. Railing posts installed into sleeves shall be provided with weep holes for condensation drainage.

- END OF SECTION -



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## **SECTION 07 11 13 - BITUMINOUS DAMPPROOFING**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Cold-applied, emulsified-asphalt dampproofing.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide auxiliary materials recommended in writing by manufacturer of primary materials.

## 2.2 PERFORMANCE REQUIREMENTS

- A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

## 2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. APOC, Inc; a division of Gardner Industries.
  - 2. BASF Corporation.
  - 3. Henry Company.
  - 4. Karnak Corporation.
  - 5. W.R. Meadows, Inc.
- B. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.

## 2.4 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
- C. Asphalt-Coated Glass Fabric: ASTM D1668/D1668M, Type I.
- D. Patching Compound: Asbestos-free fibered mastic of type recommended in writing by dampproofing manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.
- B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.

- B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.
- D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

### 3.3 APPLICATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
  - 1. Apply dampproofing to provide continuous plane of protection.
  - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
  - 1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
  - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

### 3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations: Apply one fibered brush or spray coat at not less than 3 gal./100 sq. ft..

### 3.5 PROTECTION

- A. Correct dampproofing that does not comply with requirements; repair substrates, and reapply dampproofing.

- END OF SECTION -

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## **SECTION 07 41 16 - INSULATED METAL ROOF PANELS**

### **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 SUMMARY**

- A. Section includes insulated metal roof panels.
- B. Related Sections:
  - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing and trim requirements that are included in this section or provided by the metal roof panel manufacturer.
  - 2. Section 07 72 53 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
  - 2. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 3. Review structural loading limitations of purlins and rafters during and after roofing.
  - 4. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
  - 5. Review temporary protection requirements for metal panel systems during and after installation.
  - 6. Review of procedures for repair of metal panels damaged after installation.
  - 7. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. 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.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

## 1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

## 1.10 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

## 1.11 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. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. 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. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:



1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
  2. Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:
1. Wind Loads: As indicated on Drawings.
  2. Other Design Loads: As indicated on Drawings.
  3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:
1. Test-Pressure Difference: 1.57 lbf/sq. ft..
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
1. Test-Pressure Difference: 2.86 lbf/sq. ft..
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 60.
- 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, ambient; 180 deg F, material surfaces.

## 2.2 FOAMED-INSULATION-CORE METAL ROOF PANELS

- A. General: Provide factory-formed and -assembled metal roof panels fabricated from two sheets of metal with insulation core foamed in place during fabrication with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
1. Panel Performance:
    - a. Flatwise Tensile Strength: 30 psi when tested according to ASTM C297/C297M.
    - b. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for seven days at 140 deg F and 100 percent relative humidity according to ASTM D2126.

- c. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at 200 deg F according to ASTM D2126.
  - d. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at minus 20 deg F according to ASTM D2126.
  - e. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. positive and negative wind load and with deflection of L/180 for 2 million cycles.
  - f. Autoclave: No delamination when exposed to 2-psi pressure at a temperature of 212 deg F for 2-1/2 hours.
  - g. Fire-Test-Response Characteristics: Class A according to ASTM E108.
2. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
- a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
  - b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.
  - c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.
  - d. Shear Strength: 26 psi when tested according to ASTM C273.
- B. Standing-Seam-Profile, Foamed-Insulation-Core Metal Roof Panels: Formed with vertical tongue-and-groove ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by interlocking tongue-and-groove panel edges and mechanically attaching panels to supports using concealed clips located between panels and engaging edges of adjacent panels, and mechanically seaming panels together.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- a. Metl-Span.
2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
- a. Nominal Thickness: 0.028 inch.
  - b. Exterior Finish: Two-coat fluoropolymer.
    - 1) Color: As selected by Architect from manufacturer's full range.
  - c. Interior Finish: Siliconized polyester.
    - 1) Color: As selected by Architect from manufacturer's full range.

3. Joint Type: As standard with manufacturer.
4. Panel Coverage: 42 inches.
5. Panel Thickness: 3.0 inches.
6. Thermal-Resistance Value (R-Value): 24 according to ASTM C1363.

## 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. 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.
- C. Flashing and Trim: Provide flashing and trim formed from same material as exterior facings of 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.
- D. Gutters: Formed from same material, finish, and color as exterior facings of panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match roof fascia and rake trim.
- E. Downspouts: Formed from same material, finish, and color as exterior facings of roof panels. Fabricate in 10-foot- long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.
- F. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

- G. Panel Sealants: Provide sealant types 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. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

## 2.4 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. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. 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.
- D. 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.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
  5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application but not less than thickness of metal being secured.

## 2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Exterior Facings and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
- D. Interior Facings:
  - 1. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
  - 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

### 3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal roof panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
  - 2. Shim or otherwise plumb substrates receiving metal panels.
  - 3. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 4. Install screw fasteners in predrilled holes.
  - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 6. Install flashing and trim as metal panel work proceeds.
  - 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 8. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 9. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam, Foamed-Insulation-Core Metal Roof Panels: Fasten insulated metal roof panels to supports with 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. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so cleat, insulated metal roof panel, and factory-applied side-lap sealant are completely engaged.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or,

if not indicated, provide types recommended in writing by metal roof panel manufacturer.

- G. 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. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
  - 1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
  - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
  - 1. Provide elbows at base of downspouts to direct water away from building.
- J. Roof Curbs: Install flashing around bases where they meet metal roof panels.
- K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

### 3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal panel installation, including accessories. Report results in writing.
- B. Remove and replace applications where tests and inspections indicate that they do not comply with specified requirements.

- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

### 3.6 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.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

- END OF SECTION -



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## **SECTION 07 42 13.19 - INSULATED METAL WALL PANELS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Foamed-insulation-core metal wall panels.
- B. Related Requirements:
  - 1. Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing and trim requirements that are included in this section or provided by the metal roof panel manufacturer.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
  - 2. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 3. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
  - 4. Review temporary protection requirements for metal panel assembly during and after installation.
  - 5. Review procedures for repair of metal panels damaged after installation.
  - 6. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. 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.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

## 1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

## 1.10 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

## 1.11 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. Failures include, but are not limited to, the following:

- a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.

- 2. 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. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

- a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

- 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E72:

- 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.

3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
  4. .
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
1. Test-Pressure Difference: 1.57 lbf/sq. ft..
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
1. Test-Pressure Difference: 2.86 lbf/sq. ft..
- D. 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, ambient; 180 deg F, material surfaces.

## 2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

- A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
1. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
    - a. Closed-Cell Content: 90 percent when tested according to ASTM D6226.
    - b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D1622.
    - c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.
    - d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Metl-Span.

2. Metallic-Coated Steel Sheet: Facings of zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
  - a. Nominal Thickness: 0.028 inch.
  - b. Exterior Finish: Two-coat fluoropolymer.
    - 1) Color: As selected by Architect from manufacturer's full range.
  - c. Interior Finish: Siliconized polyester.
    - 1) Color: As selected by Architect from manufacturer's full range.
3. Panel Coverage: 42 inches nominal.
4. Panel Thickness: 2.0 inches.
5. Thermal-Resistance Value (R-Value): 14 according to ASTM C1363.

## 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. 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 rakes, 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.
- C. 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, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

- E. 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. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
  - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
  - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

## 2.4 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. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. 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.
- D. 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.
  - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
  - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

## 2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
- D. Aluminum Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 2. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
  - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
  - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
    - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.



- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

### 3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Shim or otherwise plumb substrates receiving metal panels.
  - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
  - 3. Install screw fasteners in predrilled holes.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Install flashing and trim as metal panel work proceeds.
  - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
  - 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
  - 2. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

### 3.4 INSULATED METAL WALL PANEL INSTALLATION

- A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
  1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
  2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
  3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
  4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
  5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
  6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
- B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
  1. Install clips to supports with self-tapping fasteners.
- C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
  1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- D. 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. Install work with laps, joints, and seams that are permanently watertight.
  1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
- C. Metal wall panels will be considered defective if they do not pass test and inspections.
- D. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- E. Prepare test and inspection reports.

### 3.6 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.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

- END OF SECTION -

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

### **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 SUMMARY**

- A. Section Includes:
  - 1. Formed low-slope roof sheet metal fabrications.
  - 2. Formed wall sheet metal fabrications.
  - 3. Formed equipment support flashing.
- B. Related Requirements:
  - 1. Section 07 41 16 "Insulated Metal Roof Panels" for installation of sheet metal flashing and trim integral with roofing.
  - 2. Section 07 42 13.19 "Insulated Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
  - 3. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

#### **1.3 COORDINATION**

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### **1.4 ACTION SUBMITTALS**

- A. Shop Drawings: For sheet metal flashing and trim.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
  - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
  - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
  - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  - 6. Include details of termination points and assemblies.

7. Include details of roof-penetration flashing.
8. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
9. Include details of special conditions.
10. Include details of connections to adjoining work.

## 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## 1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  2. Finish Warranty Period: 20 years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and

exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent 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: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A755/A755M.
  - 1. Surface: Smooth, flat.
  - 2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - b. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.
  - 3. Color: As selected by Architect from manufacturer's full range.
  - 4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

## 2.3 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

- B. Fasteners: 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. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
  2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  3. Fasteners for Zinc-Coated (Galvanized) Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

## 2.4 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

G. Do not use graphite pencils to mark metal surfaces.

## 2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

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

B. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

C. Flashing Receivers: Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

D. Roof-Penetration Flashing: Fabricate from the following materials:

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

## 2.6 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of



wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

## 2.7 MISCELLANEOUS SHEET METAL FABRICATIONS

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
6. Do not field cut sheet metal flashing and trim by torch.
7. Do not use graphite pencils to mark metal surfaces.

- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
  - 1. Coat concealed side of sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
  - 1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
  - 1. Use sealant-filled joints unless otherwise indicated.
    - a. Form joints to completely conceal sealant.
    - b. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    - c. Adjust setting proportionately for installation at higher ambient temperatures.
  - 1) Do not install sealant-type joints at temperatures below 40 deg F.
  - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

### 3.3 INSTALLATION OF ROOF FLASHINGS

- A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.
  - 1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  - 2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
  1. Extend counterflashing 4 inches over base flashing.
  2. Lap counterflashing joints minimum of 4 inches.
- D. 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 INSTALLATION OF WALL FLASHINGS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise 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, jamb, and similar flashings to extend 4 inches beyond wall openings.

### 3.5 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
  1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  2. Weld or seal flashing with elastomeric sealant to equipment support member.

### 3.6 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.7 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### 3.8 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

- END OF SECTION -

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## **SECTION 07 72 53 - SNOW GUARDS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Rail-type, seam-mounted snow guards.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
  - 1. Include details of rail-type snow guards.
- C. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Include calculation of number and location of snow guards.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

#### **1.5 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:
1. Roof snow load.
  2. Snow drifting
  3. Roof slope.
  4. Roof type.
  5. Roof dimensions.
  6. Roofing substrate type and thickness.
  7. Snow guard type.
  8. Snow guard fastening method and strength.
  9. Snow guard spacing.
  10. Coefficient of Friction Between Snow and Roof Surface: 0.
  11. Factor of Safety: 2.
- B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Snow Loads: As indicated on Drawings.

### 2.2 RAIL-TYPE SNOW GUARDS

- A. Rail-Type, Seam-Mounted Snow Guards:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Berger Building Products, Inc.
    - b. Rocky Mountain Snow Guards, Inc.
    - c. S-5! Metal Roof Innovations, Ltd.
    - d. TRA Snow and Sun, Inc.
  2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail.
  3. Bars: ASTM B221 aluminum, clear anodized.
    - a. Profile: Round.

4. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
  1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean and prepare substrates for bonding snow guards.
- B. Prime substrates according to snow guard manufacturer's written instructions.

### **3.3 INSTALLATION**

- A. Install snow guards according to manufacturer's written instructions.
  1. Space rows as recommended by manufacturer.
- B. Attachment for Standing-Seam Metal Roofing:
  1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
  2. Rail-Type, Seam-Mounted Snow Guards:
    - a. Install brackets to vertical ribs in straight rows.
    - b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
    - c. Torque set screw according to manufacturer's instructions.
    - d. Install cross members to brackets.

- END OF SECTION -



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## **SECTION 07 92 00 - JOINT SEALANTS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Nonstaining silicone joint sealants.
  - 2. Butyl joint sealants.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant manufacturer and product name.
  - 2. Joint-sealant formulation.
  - 3. Joint-sealant color.

#### **1.4 FIELD CONDITIONS**

- A. Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
  - 2. When joint substrates are wet.
  - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## PART 2 - PRODUCTS

### 2.1 JOINT SEALANTS, 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 joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### 2.2 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. The Dow Chemical Company.

### 2.3 POLYSULFIDE JOINT SEALANTS

### 2.4 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Bostik, Inc.
    - b. Pecora Corporation.

### 2.5 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Adfast.
- b. Alcot Plastics Ltd.
- c. BASF Corporation.
- d. Construction Foam Products; a division of Nomaco, Inc.

- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), 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. Provide self-adhesive tape where applicable.

## 2.6 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 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    - a. Metal.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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 or primer 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.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind 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 in subparagraphs 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 profile per Figure 8A in ASTM C1193 unless otherwise indicated.

### 3.4 CLEANING

- A. 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.

### 3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### 3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
    - a. Joints in exterior insulation and finish systems.
    - b. Joints between metal panels.
    - c. Joints between different materials listed above.
    - d. Perimeter joints between materials listed above and frames of doors windows and louvers.
    - e. Other joints as indicated on Drawings.
  2. Joint Sealant: Insert joint sealant.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
    - a. Aluminum thresholds.

- b. Insulated metal wall panel base flashings.
  - c. Other joints as indicated on Drawings.
- 2. Joint Sealant: Butyl-rubber based.
- 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

- END OF SECTION -

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

### **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 SUMMARY**

- A. Section includes:
  - 1. Exterior standard steel doors and frames.
- B. Related Requirements:
  - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

#### **1.3 DEFINITIONS**

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

#### **1.4 COORDINATION**

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.



3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Curries Company; ASSA ABLOY.
  2. North American Door Corp.
  3. Steelcraft; an Allegion brand.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.070 U-factor when tested according to ASTM C518.

### 2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
  1. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches.
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum A60 coating.
- d. Edge Construction: Model 2, Seamless.
- e. Edge Bevel: Bevel lock edge 1/8 inch in 2 inches.
- f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- h. Core: Manufacturer's standard.

2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A60 coating.
- b. Construction: Full profile welded.

3. Exposed Finish: Factory.

## 2.4 FRAME ANCHORS

A. Jamb Anchors:

- 1. 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 of frame height above 7 feet.
- 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

- 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

## 2.5 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

## 2.6 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
  - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
  - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  - 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

## 2.7 STEEL FINISHES

- A. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### **3.2 INSTALLATION**

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. 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 without damage to completed Work.
  - 2. Floor Anchors: Secure with postinstalled expansion anchors.
    - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
  - 3. Solidly pack mineral-fiber insulation inside frames.
  - 4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
  - 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

### **3.3 REPAIR**

- A. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

- END OF SECTION -

## **SECTION 08 33 23 - OVERHEAD COILING DOORS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Insulated service doors.
- B. Related Requirements:
  - 1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type and size of overhead coiling door and accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
  - 4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
  - 1. Include similar Samples of accessories involving color selection.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Special warranty.
- B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
  - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Warranty Period: Ten years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
  - 1. Obtain operators and controls from overhead coiling-door manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:

1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
2. Testing: According to ASTM E330/E330M.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20-lbf/sq. ft. wind load, acting inward and outward.

## 2.3 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Overhead Door Corporation.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Air Infiltration: Maximum rate of 1.0 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E283.
- D. STC Rating: 21.
- E. Insulated Door Curtain R-Value: 7.
- F. Insulated Door Assembly U-Factor: 0.13.
- G. Door Curtain Material: Galvanized steel.
- H. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel and finished to match door.
- I. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- J. Hood: Match curtain material and finish.
  1. Shape: Per manufacturer.
  2. Mounting: Face of wall.
- K. Locking Devices: Equip door with chain lock keeper.
- L. Manual Door Operator: Chain-hoist operator.
- M. Curtain Accessories: Equip door with weatherseals.



- N. Door Finish:
  - 1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
  - 2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

## 2.4 MATERIALS, GENERAL

## 2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
  - 1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
  - 2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
  - 3. Metal Interior Curtain-Slat Facing: Match metal and thickness of exterior curtain-slat face.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

## 2.6 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
  - 1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.

## 2.7 LOCKING DEVICES

- A. Chain Lock Keeper: Suitable for padlock.

## 2.8 CURTAIN ACCESSORIES

- A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
  - 1. At door head, use 1/8-inch- thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
  - 2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.

## 2.9 COUNTERBALANCE MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

## 2.10 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

## 2.11 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.12 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

### 3.3 FIELD QUALITY CONTROL

- A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

### 3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
  - 1. Adjust exterior doors and components to be weather resistant.

- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide tight fit around entire perimeter.

### 3.5 MAINTENANCE SERVICE

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

- END OF SECTION -

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## **SECTION 08 36 13 - SECTIONAL DOORS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Sectional-door assemblies.
- B. Related Requirements:
  - 1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type and size of sectional door and accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
- B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.
  - 1. Include plans, elevations, sections, and mounting details.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Sample Warranties: For manufacturer's warranty and finish warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For sectional doors to include in maintenance manuals.
- B. Manufacturer's warranty.
- C. Finish warranty.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

## 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Failure of components or operators before reaching required number of operation cycles.
    - c. Faulty operation of hardware.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
    - e. Delamination of exterior or interior facing materials.
  - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Warranty Period: Ten years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain sectional doors from single source from single manufacturer.
  - 1. Obtain operators and controls from sectional door manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
2. Testing: In accordance with ASTM E330/E330M.
3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design sectional doors to remain operable under uniform pressure (velocity pressure) of 20 lbf/sq. ft. wind load, acting inward and outward.

## 2.3 SECTIONAL-DOOR ASSEMBLY

- A. Steel Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Overhead Door Corporation.
- B. Operation Cycles: Door components and operators capable of operating for not less than 10,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.
- C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. when tested in accordance with ASTM E283 or DASMA 105.
- D. U-Value: 0.102.
- E. Steel Door Sections: ASTM A653/A653M, zinc-coated (galvanized), cold-rolled, commercial steel sheet with G90 zinc coating.
  1. Door-Section Thickness: 2 inches.
  2. Section Faces:
    - a. Thermal-Break Construction: Provide sections with continuous thermal-break construction separating the exterior and interior faces of door.
    - b. Exterior Face: Fabricated from single sheets, not more than 24 inches high; with horizontal meeting edges rolled to continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove, weather- and pinch-resistant seals and reinforcing flange return.
      - 1) Steel Sheet Thickness: 0.022-inch nominal coated thickness.
      - 2) Surface: Manufacturer's standard, flat.
    - c. Interior Face: Enclose insulation completely within steel exterior facing and interior facing material, with no exposed insulation. Provide the following interior-facing material:



- 1) Zinc-Coated (Galvanized) Steel Sheet: With minimum nominal coated thickness of 0.022 inch.
3. End Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.040-inch nominal coated thickness and welded to door section.
  4. Section Reinforcing: Horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.
    - a. Bottom Section: Reinforce section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal (weatherseal).
    - b. Hardware Locations: Provide reinforcement for hardware attachment.
  5. Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free insulation of type indicated below:
    - a. Board Insulation: Polystyrene, secured to exterior face sheet.
    - b. Fire-Resistance Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, in accordance with ASTM E84.
- F. Track: Manufacturer's standard, galvanized-steel, standard-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.
1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 zinc coating.
  2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
  3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches apart for door-drop safety device.
    - a. Horizontal Track: Provide continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.
- G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom top and jambs of door.
- H. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.
1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.
    - a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.

2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.
    - a. Roller-Tire Material: Manufacturer's standard.
  3. Push/Pull Handles: Equip each door with galvanized-steel lifting handles on each side of door, finished to match door.
- I. Locking Device:
1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
- J. Counterbalance Mechanism:
1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
  2. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.
  3. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
  4. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.
- K. Manual Door Operator:
1. Push-Up Operation: Lift handles and pull rope for raising and lowering doors located on inside and outside of bottom section; with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.
- L. Metal Finish: Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
1. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
    - a. Color and Gloss: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.
- B. Tracks:
  - 1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches apart.
  - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

### 3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

### 3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touchup Painting Galvanized Material: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

- END OF SECTION -

## **SECTION 08 62 00 - UNIT SKYLIGHTS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Tubular daylighting devices.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include product dimensions, construction details, material descriptions, dimensions and profiles of components, and finishes.
  - 2. Include power requirements, ratings, characteristics, and mounting requirements for electrical components.

#### **1.4 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of products that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Water leakage not controlled by drainage features.
    - c. Deterioration of materials and finishes beyond normal weathering.
    - d. Yellowing of acrylic glazing.
    - e. Breakage of polycarbonate glazing.
    - f. Deterioration of insulating-glass units including failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating-glass units contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
  - 2. Warranty Period:
    - a. Products and Accessories: Five years from date of Substantial Completion.
    - b. Insulating-Glass Units: 10 years from date of Substantial Completion.

- B. Special Aluminum Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of finish deterioration within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, peeling, checking, or chipping.
  2. Warranty Period: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Performance Standard: Comply with AAMA/WDMA/CSA 101/1.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
1. Minimum Performance Grade: PG 30.
  2. Label Requirements: Label each product with names of manufacturer and labeling agency and AAMA/WDMA/CSA 101/1.S.2/A440 product designation, performance grade, and test specimen size equal to or greater than the size of the product.
  3. Certification Requirements: Provide AAMA or WDMA certified products, with label attached to each.
- B. Devices to provide a minimum average illuminance of 45 fc throughout the building footprint.
- C. Thermal Transmittance: NFRC 100 maximum U-factor of 0.88.
- D. Plastic Glazing:
1. Self-Ignition Temperature: 650 deg F or more for plastic sheets in thickness indicated when tested in accordance with ASTM D1929.
  2. Smoke-Production Characteristics: Smoke-developed index of 450 or less when tested in accordance with ASTM E84, and smoke density of 75 or less when tested in accordance with ASTM D2843.
  3. Combustibility Characteristics: Tested in accordance with ASTM D635 and classified for burning rate of nominal thickness of 0.060 inch or thickness of plastic glazing indicated for use as follows:
    - a. Class CC1: Burning rate of 1 inch per minute or less.
    - b. Class CC2: Burning rate of 2-1/2 inches per minute or less.

- E. Fall-Protection Performance: Installed assemblies are capable of safely supporting the greater of 400 lbs or twice the weight of employees, equipment, and materials that may be imposed on any 1 sq. foot of the assembly at any time.

## 2.2 TUBULAR DAYLIGHTING DEVICES

- A. Tubular Daylighting Device: Complete with exterior glazed opening, glazing retainers and gaskets, exterior flashing assembly, reflective tube, interior diffuser assembly, and components and accessories required to provide a complete installation.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Solatube International, Inc.
- B. Product Type: AAMA/WDMA/CSA 101/1.S.2/A440 TDDOC, tubular daylighting device - open ceiling.
- C. Nominal Reflective Tube Diameter: 21 inches.
- D. Exterior Glazing: Manufacturer's standard collector dome and cylinder.
  - 1. Size: As required to coordinate with reflective tube.
  - 2. Material:
    - a. Acrylic: ASTM D4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber); and Class CC2 based on testing in accordance with ASTM D635.
    - b. Minimum Thickness: 0.143 inch.
  - 3. Seal: Manufacturer's standard.
  - 4. Exterior Glazing Accessories:
    - a. Secondary Diffuser: Manufacturer's standard ASTM D4802 acrylic, Class CC2 based on testing in accordance with ASTM D635.
- E. Exterior Flashing: Manufacturer's standard one-piece, self-mounted type.
  - 1. Size: As required to coordinate with exterior glazing and reflective tube.
  - 2. Base Pitch: 4.76 degree slope from horizontal.
  - 3. Base Height: 8 inches.
  - 4. Material: Manufacturer's standard corrosion-resistant metal and finish.
  - 5. Tube Attachment: Manufacturer's standard receiver attached to top of roof flashing and serving as mounting base for dome assembly; provides thermal break between flashing and reflective tube; configured to channel condensed moisture to the exterior.
    - a. Seal: Manufacturer's standard that provides weathertight seal with roof flashing.

6. Flashing Accessories:

- a. Flashing Insulation: Manufacturer's standard thermal isolation material.

F. Reflective Tube:

- 1. Rigid Tube: Light shaft formed from aluminum sheet, ASTM B209, with manufacturer's standard specular interior finish.
  - a. Thickness: Manufacturer's standard.
  - b. Length and Configuration: 3'-0".
    - 1) Tube Extensions: Provide manufacturer's standard components as required to accommodate installation areas indicated.
  - c. Fastening System: Manufacturer's standard that provides tight mating of interconnecting tube component pieces.

G. Accessories:

- 1. Daylight Dimmer: Manufacturer's standard dimmer baffle, electro-mechanical, and complete with power supply, switch, and daylight valve that adjusts daylight output when actuated.

## 2.3 ACCESSORY MATERIALS

- A. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal that is compatible with the materials being fastened and as recommended in writing by manufacturer. Finish exposed fasteners to match material being fastened.
- B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate installation of products and accessories with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure

that each element of the Work performs properly and that combined elements are waterproof and weathertight.

- B. Install products and accessories to comply with recommendations in AAMA 1607 and with manufacturer's written installation instructions.
- C. Install products true to line and without distortion.
- D. Anchor products securely to supporting substrates.
- E. Where metal surfaces of products will contact other metal or corrosive substrates, such as preservative-treated wood, apply bituminous coating on concealed metal surfaces or provide other approved permanent separation recommended in writing by manufacturer.

### 3.3 CLEANING AND ADJUSTING

- A. Clean exposed product surfaces in accordance with manufacturer's written instructions. Touch up damaged metal coatings and finishes.
- B. Remove excess sealants, glazing materials, dirt, and other substances.
- C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect product surfaces from contact with contaminating substances resulting from construction operations.

- END OF SECTION -



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## **SECTION 08 71 00 - DOOR HARDWARE**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Mechanical door hardware for the following:
    - a. Swinging doors.
  - 2. Cylinders for door hardware specified in other Sections.
- B. Related Requirements:
  - 1. Section 08 11 13 "Hollow Metal Doors and Frames".
  - 2. Section 08 33 23 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
  - 3. Section 08 36 13 "Sectional Doors" for door hardware provided as part of Sectional door assemblies.

#### **1.3 COORDINATION**

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors,

frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

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 the fabrication of other work that is critical in Project construction schedule.
  2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
  3. Content: Include the following information:
    - a. Identification number, location, hand, size, and material of each door and frame.
    - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
    - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
    - d. Fastenings and other installation information.
    - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
    - f. Mounting locations for door hardware.
- C. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

## 1.5 CLOSEOUT SUBMITTALS

- A. Schedules: Final door hardware and keying schedule.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including excessive deflection, cracking, or breakage.
    - b. Faulty operation of doors and door hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
    - a. Exit Devices: Two years from date of Substantial Completion.
    - b. Manual Closers: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2010 ADA Standards for Accessible Design" and Title 24, Part 2.
  - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
  - 2. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
  - 3. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

### 2.3 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Allegion plc.
- b. Hager Companies.
- c. McKinney Products Company; an ASSA ABLOY Group company.
- d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

## 2.4 EXIT DEVICES AND AUXILIARY ITEMS

### A. Exit Devices and Auxiliary Items: BHMA A156.3.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Allegion plc.
  - b. Von Duprin.

## 2.5 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Best Access Systems; Stanley Security Solutions, Inc.; CORMAX.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
  - 1. Core Type: Interchangeable.
- C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

## 2.6 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.
  - 1. Master Key System: Change keys and a master key operate cylinders.
    - a. Provide three cylinder change keys and five master keys.
- B. Keys: Nickel silver.

## 2.7 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Allegion plc.
    - b. Arrow USA; an ASSA ABLOY Group company.
    - c. Norton Door Controls; an ASSA ABLOY Group company.
    - d. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
    - e. SARGENT Manufacturing Company; ASSA ABLOY.

## 2.8 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. National Guard Products, Inc.
    - b. Pemko; an ASSA ABLOY Group Company.
    - c. Zero International; an Allegion brand.
- B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
  - 1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
  - 2. Gasketing on Double Doors: 0.50 cfm per ft. of door opening.

## 2.9 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. National Guard Products, Inc.
    - b. Pemko; an ASSA ABLOY Group Company.
    - c. Zero International; an Allegion brand.

## 2.10 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
  - 1. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
  - 2. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

## 2.11 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. 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 of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

## 3.3 INSTALLATION

- A. Mounting Heights: 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.

- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
  - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
  - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
  - 1. Replace construction cores with permanent cores as directed by Owner.
- E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."
- F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
  - 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- G. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.4 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.

### 3.5 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 that door hardware is without damage or deterioration at time of Substantial Completion.

### 3.6 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

### 3.7 DOOR HARDWARE SCHEDULE

- A. Hardware Set 1: Each single door (301, 501, 600A and 600C) to have the following:

3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	EXIT HARDWARE	LD-98-L	626	VON
1	EA	SFIC RIM CYLINDER	1E72 CORMAX	626	BES
1	EA	SURFACE CLOSER	4040XP HCUSH TBWMS	689	LCN
1	EA	GASKETING	429A-S	A	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

- B. Hardware Set 2: Each pair of double doors (500D) to have the following:

6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	EXIT HARDWARE	LD-9847-L-LBR	626	VON
1	EA	EXIT HARDWARE	LD-9847-EO-LBR	626	VON
1	EA	SFIC RIM CYLINDER	1E72 CORMAX	626	BES
2	EA	SURFACE CLOSER	4040XP HCUSH TBWMS	689	LCN
1	EA	GASKETING	429A-S	A	ZER
1	EA	MEETING STILES	328A-S	A	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER

- END OF SECTION -

## **SECTION 08 91 16 - OPERABLE WALL LOUVERS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Operable, extruded-aluminum louvers.

#### **1.3 DEFINITIONS**

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.
  - 3. Wiring Diagrams: For power, signal, and control wiring for motorized operable louvers.

## 1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

## 1.6 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain operable and fixed louvers from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures to the face of the building shall be considered to act normal.
  - 1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.
- B. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

- E. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

## 2.3 OPERABLE EXTRUDED-ALUMINUM LOUVERS

- A. Louver Construction and Operation: Provide operable louvers with extruded-aluminum frames and blades of not less than 0.080-inch nominal thickness, and with operating mechanisms to suit louver sizes.
  - 1. Motor operation with two-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch; equipped with terminals for controlling devices.
- B. Single-Blade Operable Louver:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. All-Lite Architectural Products.
    - b. Cesco Products; a division of MESTEK, Inc.
    - c. Metal Form Manufacturing, Inc.
    - d. Ruskin Company.
    - e. Vent Products Co., Inc.
  - 2. Louver Depth: 6 inches.
  - 3. Blade Type: Drainable.
  - 4. Accessories: Equip louvers as follows:
    - a. Vinyl blade-edge gaskets for each louver blade.
    - b. flexible, compressible aluminum jamb seals.
  - 5. Louver Performance Ratings:
    - a. Free Area: Not less than 7.5 sq. ft. for 48-inch- wide by 48-inch- high louver.
    - b. Point of Beginning Water Penetration: Not less than 1000 fpm.

## 2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
  - 1. Screen Location: Interior face unless otherwise indicated.
  - 2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
  2. Finish: Same finish as louver frames to which louver screens are attached.
  3. Type: Rewirable frames with a driven spline or insert.
- D. Louver Screening for Aluminum Louvers:
1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

## 2.5 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
  2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
1. Frame Type: Exterior flange unless otherwise indicated.
- C. Include supports, anchorages, and accessories required for complete assembly.
- D. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## 2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color

coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

### 3.3 ADJUSTING AND CLEANING

- A. Test operable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

- END OF SECTION -

## **SECTION 08 91 19 - FIXED LOUVERS**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Fixed extruded-aluminum louvers.

#### **1.3 DEFINITIONS**

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.



- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.
- D. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

#### 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

#### 1.8 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.

- b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- 2. Warranty Period: 10 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain fixed and operable louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic protection, when tested according to AMCA 540.
- D. Seismic Performance: As indicated on drawings.
- E. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Component Importance Factor: 1.0.
- F. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- H. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

## 2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

### A. Horizontal Drainable-Blade Louver:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Architectural Louvers; Harray, LLC.
  - b. Cesco Products; a division of MESTEK, Inc.
  - c. Ruskin Company.
  - d. Vent Products Co., Inc.
2. Louver Depth: Per HVAC Schedule.
3. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.080 inch for frames.
4. Mullion Type: Exposed.
5. Louver Performance Ratings:
  - a. Free Area: Not less than Per HVAC Schedule.
  - b. Point of Beginning Water Penetration: Not less than 900 fpm.
  - c. Air Performance: Not more than 0.15-inch wg static pressure drop at Insert value free-area intake velocity.
6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

## 2.4 LOUVER SCREENS

### A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Insect screening.

### B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

### C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Rewirable frames with a driven spline or insert.

### D. Louver Screening for Aluminum Louvers:

1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

## 2.5 MATERIALS

### A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
  - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
  - 2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Exterior flange unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide subsills made of same material as louvers for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## 2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color

coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

### **3.3 INSTALLATION**

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

### **3.4 ADJUSTING AND CLEANING**

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

- END OF SECTION -

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## **SECTION 09 96 00 - PROTECTIVE COATINGS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.
- B. Definitions
  - 1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.
  - 2. The term "DFT" means minimum dry film thickness, without any negative tolerance.
- C. The following surfaces shall not be coated, unless specifically noted otherwise in the Contract Documents:
  - 1. Fibrous Reinforced Plastic (FRP)/fiberglass surfaces
  - 2. Stainless steel surfaces
  - 3. Aluminum surfaces NOT in contact with concrete
  - 4. Bronze, brass, or copper surfaces
  - 5. Concrete, unless required by items on the concrete coating schedule below or the Drawings
  - 6. Electrical conduit
  - 7. Machined surfaces
  - 8. Grease fittings
  - 9. Glass
  - 10. Equipment nameplates
  - 11. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated
- D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.



- E. Where protective coatings are to be performed by a Subcontractor, the Subcontractor shall possess a valid state license as required for performance of the painting and coating WORK called for in this specification and shall provide at least five (5) references which show that the Subcontractor has previous successful experience with the indicated or comparable coating systems. Include the name, address, and the telephone number for the owner of each installation for which the Subcontractor provided the protective coating.

## 1.2 REGULATORY REQUIREMENTS

- A. **Environmental Protection.** In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify the OWNER of any coating system specified herein which fails to conform to such requirements.
  - 1. **Lead Content.** Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content
  - 2. **Chromate Content.** Do not use coatings containing zinc-chromate or strontium-chromate
  - 3. **Asbestos Content.** Materials shall not contain asbestos
  - 4. **Mercury Content.** Materials shall not contain mercury or mercury compounds.
  - 5. **Silica.** Abrasive blast media shall not contain free crystalline silica.
  - 6. **Human Carcinogens.** Materials shall not contain ACGIH 0100Doc and ACGIH 0100Doc confirmed human carcinogens (A1) or suspected human carcinogens.

## 1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Paint coatings removal and application shall be in accordance with the following standards, as applicable:
  - 1. National Standard Format (NSF) and American National Standards Institute (ANSI), NSF/ANSI 61 (2012) Drinking Water System Components.
  - 2. American Water Works Association AWWA D102 Coating Steel Water Storage Tanks
  - 3. The Society for Protective Coatings (SSPC) and The National Association of Corrosion Engineers (NACE):
    - NACE TM-01-70 (1970) Visual Standard For Surfaces of New Steel Airblast Cleaned With Sand Abrasive
    - NACE TM-01-75 (1975) Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Grit and Shot
    - SSPC SP 1 (1982; E 2004) Solvent Cleaning

SSPC SP 2 (1982; E 2004) Hand Tool Cleaning  
SSPC SP 3 (1982; E 2004) Power Tool Cleaning  
SSPC SP5/NACE No. 1 (2007) White Metal Blast Cleaning  
SSPC SP6/NACE No.3 (2007) Commercial Blast Cleaning  
SSPC SP7/NACE No.4 (2007) Brush-Off Blast Cleaning  
SSPC SP10/NACE No.2 (2007) Near-White Blast Cleaning

#### 1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating WORK:
1. Materials List: Eight copies of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.
  2. Manufacturer's Information: For each coating system to be used, the following data:
    - a. Manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.
    - b. Technical and performance information that demonstrates compliance with the system performance and material requirements.
    - c. Paint manufacturer's instructions and recommendations on surface preparation and environmental conditions for application.
    - d. Colors available for each product (where applicable).
    - e. Compatibility of shop and field applied coatings (where applicable).
    - f. Material Safety Data Sheet for each product proposed.
- C. Samples
1. Samples of paint, finishes, and other coating materials shall be submitted on 8-1/2" x 11" sheet metal pieces. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.
  2. Two sets of color samples to match each color selected by the OWNER from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the OWNER. The color formula shall be shown on the back of each color sample.
  3. One 1-pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

## 1.5 QUALITY ASSURANCE

- A. The CONTRACTOR shall verify with the authorities having jurisdiction over air pollution control, the use of any materials containing organic chemical compounds of which use at the date of installation may be prohibited or restricted by any regulations then in effect.
- B. Materials shall be subject to such tests as the ENGINEER may require. Costs of such testing shall be paid according to the General Conditions.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The coating materials shall be delivered to the Site in the manufacturer's unopened containers. A list of all batch numbers shall be furnished to the ENGINEER prior to the start of work.
- B. Stored coatings shall be kept covered, and precautions shall be taken for the prevention of fire. Empty containers and soiled or oily rags shall be removed from the Site at the end of each day's work. Paint thinner shall not be stored in a room scheduled to receive resilient flooring.

## 1.7 ATMOSPHERIC CONDITIONS

- A. No coating shall be applied:
  - 1. when the surrounding air temperature or the temperature of the surface to be coated is below 40 degrees F
  - 2. to wet or damp surfaces or in rain, fog or mist
  - 3. when the temperature is less than 5 degrees F above the dew point
  - 4. when it is expected the air temperature will drop below 40 degrees F, or less than 5 degrees F above the dew point within 8 hours after application of coating. Dew point shall be measured by use of a sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau psychrometric tables.

## 1.8 SAFETY AND HEALTH REGULATIONS

- A. **General:** In accordance with requirements of OSHA Safety and Health Standards for Construction (29CFR1926) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions and appropriate technical bulletins and manuals, the CONTRACTOR shall provide and require use of personnel protective equipment for persons working in or about the Site.
- B. **Head and Face Protection and Respiratory Devices:** Equipment shall include protective helmets which shall be worn by all persons while in the vicinity of the WORK. In addition, workers engaged in or near the work during sandblasting shall wear OSHA approved eye and face protection devices and air purifying, halfmask or mouthpiece respirators. Barrier creams may be used on any exposed areas of skin.

- C. **Ventilation:** Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Forced air ventilation shall be provided to reduce the concentration of air contaminant to a safe limit. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.
- D. **Sound Levels:** Whenever the occupational noise exposure exceeds maximum allowable sound levels, the CONTRACTOR shall implement a Hearing Conservation Program including furnishing and requiring the use of approved ear protective devices.
- E. **Illumination:** Adequate illumination shall be provided while work is in progress, which may include explosion-proof lights and electrical equipment. Whenever required by the ENGINEER, the CONTRACTOR shall provide additional illumination to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the ENGINEER.
- F. **Temporary Ladders and Scaffolding:** All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the ENGINEER to facilitate inspection and shall be moved by the CONTRACTOR to locations as requested by the ENGINEER.

## 1.9 CLEANUP

- A. Upon completion of the work, staging, scaffolding, and containers shall be removed from the Site. Coating spots and oil or stain upon adjacent surfaces shall be removed. Damage to adjacent surfaces or facilities resulting from the WORK performed under this Section shall be cleaned, repaired, or refinished to the satisfaction of the ENGINEER.

## 1.10 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

- A. **Inspection:** An inspection may be conducted by the OWNER during the tenth month following completion of coating WORK. When specified for specific systems, the CONTRACTOR and a representative of the coating material manufacturer shall attend this inspection. Defective WORK shall be repaired in accordance with these specifications and to the satisfaction of the OWNER. The OWNER may, by written notice to the CONTRACTOR, reschedule the inspection to another date within the one year warrantee period or may cancel the inspection altogether. The CONTRACTOR is not relieved of its responsibilities to correct defects, whether or not the inspection is conducted.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. **Suitability:** The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.
- B. **Material Sources:** Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does

comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

- C. **Compatibility:** In any coating system only compatible materials from a single manufacturer shall be used in the WORK. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.
- D. **Containers:** Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.
- E. **Colors:** Colors and shades of colors of coatings shall be as indicated or selected by the OWNER. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the OWNER or ENGINEER.
- F. Substitute or "Or-Equal" Products
  - 1. To establish equality under Section 01 60 00 - Products, Materials, Equipment and Substitutions, the CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:
    - a. Quality
    - b. Durability
    - c. Resistance to abrasion and physical damage
    - d. Life expectancy
    - e. Ability to recoat in future
    - f. Solids content by volume
    - g. Dry film thickness per coat
    - h. Compatibility with other coatings
    - i. Suitability for the intended service
    - j. Resistance to chemical attack
    - k. Temperature limitations during application and in service
    - l. Type and quality of recommended undercoats and topcoats
    - m. Ease of application

- n. Ease of repairing damaged areas
  - o. Stability of colors
2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. When requested, the CONTRACTOR shall provide the ENGINEER with the names of not less than 10 successful applications of the proposed manufacturer's products that comply with these requirements.
  3. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear such costs involved as part of the WORK.

## 2.2 SPECIAL COATING SYSTEMS

### A. System 20 - Acrylic Latex

#### 1. Material

Primer	Product, surface preparation, and DFT as recommended by manufacturer for the surface
Finish Type	Single component, water based acrylic latex, with fungicide
VOC Content, max	180 grams per gallon
Demonstrated suitable for	PVC piping, weather and mild chemical resistance, excellent color and gloss retention

#### 2. Application and manufacturers

Surface Preparation	Finish (at least 2 coats required)	Total System DFT
SSPC SP1, min	<b>Ameron Amercoat 220</b>	primer plus 6 mils
	<b>Carboline Carbocrylic 3359</b>	
	<b>Tnemec Tneme-Cryl 6</b>	

### B. System 50 - Amine Cure Epoxy

#### 1. Material

Type	high build, amine cure epoxy
VOC content, g/L max	220
Demonstrated suitable for	steel, long term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Surface Preparation	Products (3 coats or more)	Total System DFT
SSPC SP10	<b>Amerlock 2</b>	15 to 17 mils
	<b>Carboline Carboguard 891</b>	For non-submerged valves and other equipment, DFT = 10 to 12 mils
	<b>Devco Bar-Rust 233H</b>	

C. **System 51 (VOC-Limited) - Polyamide Epoxy**

1. Materials

Type	high build polyamide cure epoxy
VOC content, max, g/L	250
Demonstrated suitable for	long term immersion in water and wastewater, resistant to corrosion and chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Surface Preparation	Products (3 coats or more)	Total System DFT
SSPC SP10	<b>Devco Bar-Rust 233H</b>	12 - 18 mils
	<b>Tnemec V140F</b>	
	<b>Ameron Amerlock 400/2</b>	

D. **System 100 - PVC Tape Pipe Wrap:** Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

E. **System 102 – Concrete Raceways and Fish Ladder:** All interior concrete surfaces holding fish, including but not limited to the Coho Raceways, Chinook Raceways, Adult Holding Ponds, and Fish Ladder, shall be coated with a polyurethane coating as follows;

1. Material

Type	Epoxy-like Polyurethane Coating
Demonstrated suitable for	Concrete substrates to provide a VOC free, smooth, fish friendly surface.
VOC content, max	250

2. Application and manufacturers

Surface Preparation	Primer	Coating (DFT = 80-100 mils)
SSPC SP1	Primall – 160 Epoxy Primer by LifeLast Inc.	DuraShield 310 by LifeLast, Inc.

F. **System 108 - Aluminum Metal Isolation**

1. Material

Type	high build polyamide epoxy with chemical and abrasion resistance
Demonstrated suitable for	concrete and aluminum substrates, to isolate aluminum from contact with concrete and the resulting chemical degradation
VOC content, max	250

2. Application and manufacturers

Surface Preparation	Coating (DFT = 16 - 20 mils)
	Ameron Amercoat 351



	Sherwin Williams Macropoxy 646
	Tnemec Epoxoline 80

## PART 3 -- EXECUTION

### 3.1 MANUFACTURER'S SERVICES

- A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

### 3.2 WORKMANSHIP

- A. Skilled craftsmen and experienced supervision shall be used on coating WORK.
- B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.
- C. Damage to other surfaces resulting from the WORK shall be cleaned, repaired, and refinished to original condition.
- D. In no case shall paint application exceed the paint manufacturer's published coverage rate based upon unthinned material. In the event that paint has been extended beyond the recommended coverage, or the "hide" produced is inadequate, as determined by the ENGINEER, the CONTRACTOR shall apply one or more additional coats as determined by the ENGINEER. The manufacturer's recommended amount of thinner shall not be exceeded. Unless otherwise approved, finish coat material shall be applied as taken from manufacturer's container.

### 3.3 STORAGE, MIXING, AND THINNING OF MATERIALS

- A. **Manufacturer's Recommendations:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.
- B. Coating materials shall be used within the manufacturer's recommended shelf life.
- C. **Storage and Mixing:** Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

### 3.4 PREPARATION FOR COATING

- A. **General:** Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.
- B. **Protection of Surfaces Not to be Coated:** Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.
- C. Hardware, lighting fixtures, switchplates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.
- D. Care shall be exercised not to damage adjacent WORK during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent WORK or adjoining property occurring from blasting or coating operations.
- E. **Protection of Painted Surfaces:** Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces.

### 3.5 SURFACE PREPARATION STANDARDS

- A. **Steel Structures Painting Council (SSPC) Standards.** The following referenced standards for surface preparation according to specifications of the Steel Structures Painting Council (SSPC) shall form a part of this specification:
  - 1. **SSPC SP1 - Solvent Cleaning:** Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
  - 2. **SSPC SP2 - Hand Tool Cleaning:** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
  - 3. **SSPC SP3 - Power Tool Cleaning:** Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
  - 4. **SSPC SP5 - White Metal Blast Cleaning:** Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. **SSPC SP6 - Commercial Blast Cleaning:** Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.
6. **SSPC SP7 Brush-Off Blast Cleaning:** Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.
7. **SSPC SP10 Near-White Blast Cleaning:** Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.
8. **SSPC-SP13 Surface Preparation of Concrete:** Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

### 3.6 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

- A. Surface preparation shall not begin until at least 30 Days after the concrete or masonry has been placed.
- B. Oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.
- C. Concrete, concrete block masonry surfaces, and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.
- D. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, rinse surfaces with water and test the pH. The pH shall be between neutral and 8.
- E. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.
- F. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as **Delmhorst Model BD**, or equal.

### 3.7 APPLICATION OF COATINGS

- A. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The CONTRACTOR shall schedule such inspection with the ENGINEER in advance.
- B. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

- C. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to occur. Use stripe painting with a brush in these areas.
- D. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.
- E. Coatings shall not be applied under the following conditions:
  - 1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.
  - 2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.
  - 3. Dust or smoke laden atmosphere.
  - 4. Damp or humid weather.
  - 5. Substrate or air temperature is less than 5 degrees F above the dew point.
  - 6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.
  - 7. Wind conditions are not calm.
- F. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.
- G. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

### 3.8 CURING OF COATINGS

- A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.
- B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

### 3.9 SHOP AND FIELD INSPECTION AND TESTING

- A. **General:** The CONTRACTOR shall give the ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.
- B. Such WORK shall be performed only in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such WORK in its absence.

- C. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the WORK in accordance with these Specifications.
- D. Scaffolding shall be erected and moved to locations where requested by the ENGINEER to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.
- E. **Inspection Devices:** The CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the ENGINEER's use while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the ENGINEER.
- F. **Holiday Testing:** The CONTRACTOR shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturers printed instructions and then be retested.
1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20**, or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.
  2. Coatings with thickness of 20-mils or less total DFT: **Tinker & Rasor Model M1** non-destructive type holiday detector, **K-D Bird Dog**, or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo** or equal, shall be added to the water prior to wetting the detector sponge.
- G. **Surface Preparation:** Evaluation of blast cleaned surface preparation will be based upon comparison of the blasted surfaces with the standard samples available from NACE, using NACE standards TM-01-70 and TM-01-75.

### 3.10 COATING SYSTEM SCHEDULE-CONCRETE

Surface Type	Surface / Equipment / Area Description	Surface Preparation Requirements	System No.
C-1	Surfaces submerged in water and holding fish.	Per paragraph 3.9	(102) Polyurethane, concrete

### 3.11 COATING SYSTEM SCHEDULE – FERROUS METAL – NOT GALVANIZED

<b>Surface Type</b>	<b>Surface / Equipment / Area Description</b>	<b>Surface Preparation Requirements</b>	<b>System No.</b>
FM-6	Buried small steel pipe.	Removal of dirt, grease, oil	(100) PVC tape
FM-14	Structural steel and miscellaneous metalwork other than stainless or weathering steel.	Near white metal blast cleaning SSPC SP10	(50) Amine cure epoxy

### 3.12 COATING SYSTEM SCHEDULE – NON-FERROUS METAL, PLASTIC, FIBER GLASS

<b>Surface Type</b>	<b>Surface / Equipment / Area Description</b>	<b>Surface Preparation Requirements</b>	<b>System No.</b>
NFS-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC SP1	(108) Aluminum metal isolation

- END OF SECTION -

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## **SECTION 10 21 23 - CUBICLE CURTAINS AND TRACK**

### **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 SUMMARY**

- A. Section Includes:
  - 1. Cubicle-curtain tracks and carriers.
  - 2. Cubicle curtains.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.
- B. Shop Drawings: For curtains and tracks.
  - 1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
  - 2. Include details of blocking for track support.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Curtain Carriers and Track End Caps: Full-size units equal to 3 percent of amount installed for each size indicated, but no fewer than 10 units.



## PART 2 - PRODUCTS

### 2.1 CUBICLE-CURTAIN SUPPORT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Goff's Curtain Walls.
- B. 304 Stainless steel track and trolley system.
  - 1. Track Minimum Wall Thickness: Manufacturer's standard.
  - 2. Finish:Stainless steel.
- C. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
  - 1. Suspended-Track Support: Not less than 7/8-inch- OD tube.
  - 2. End Stop: Removable with carrier hook.
- D. Curtain Roller Carriers: Manufacturer's standard.
- E. Exposed Fasteners: Stainless steel.
- F. Concealed Fasteners: Stainless steel.

### 2.2 CURTAINS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Goff's Curtain Walls.
- B. Material: 40 Mil double polished clear PVC
- C. Length: Coordinate length of curtains and pass through openings with user. Provide a minimum on 6" overlap at all pass through opening locations
- D. Curtain Grommets: Manufacturer's standard.

### 2.3 CURTAIN FABRICATION

- A. Continuous Curtain Panels:
  - 1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches of added fullness.

2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of As indicated on Drawings.
3. Top Hem: Manufacturer's standard.
4. Bottom Hem: Manufacturer's standard, weighted.
5. Side Hems: Manufacturer's standard.
6. Vertical Seams: Manufacturer's standard.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install tracks level and plumb, according to manufacturer's written instructions.
- B. For tracks of up to 20 feet in length, provide track fabricated from single, continuous length.
  1. Curtain-Track Mounting: Suspended.
- C. Suspended-Track Mounting: Install track with manufacturer's standard suspended supports at intervals and with fasteners recommended by manufacturer. Fasten supports to structure. Provide supports at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.
- D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along full length of curtain plus an additional carrier.
- F. Cubicle Curtains: Hang curtains on each curtain track.

- END OF SECTION -

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## **SECTION 10 44 16 - FIRE EXTINGUISHERS**

### **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 SUMMARY**

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

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Warranty: Sample of special warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### **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 when testing interval required by NFPA 10 is within the warranty period.
    - 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."

### 2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Amerex Corporation.
    - b. Buckeye Fire Equipment Company.
    - c. Kidde Residential and Commercial Division.
  - 2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
  - 3. Valves: Manufacturer's standard.
  - 4. Handles and Levers: Manufacturer's standard.
  - 5. 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 in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

### 2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Amerex Corporation.
  - 2. Buckeye Fire Equipment Company.
  - 3. Kidde Residential and Commercial Division.
  - 4. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
  - 1. Mounting Brackets: Top of fire extinguisher to be at 42 inches above finished floor.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

- END OF SECTION -

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## SECTION 11 94 01 - FIBERGLASS TANKS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The work includes furnishing all labor, materials and equipment for the installation of fiberglass fish feeding vessels as shown on the drawings and as specified herein.
- B. Provide the following:
  - 1. Two (2) rectangular vessels; 20'-0" long, 5'-1" wide, 4'-0" deep fiberglass feeding tanks, including removable drain standpipes and screen slots as shown on the Drawings and specified herein. The water depth would be 3 feet with 1-foot of freeboard.

#### 1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

##### A. Commercial Standards

ASTM C 581	Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service
ASTM D 638	Test Method for Tensile Properties of Plastics
ASTM D 695	Test Method for Compressive Properties of Rigid Plastics
ASTM D 790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Definitions of Terms Relating to Plastics
ASTM D 2563	Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D 2583	Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D 3299	Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
ASTM D 4097	Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks

- B. When 2 or more of the above regulations are applicable, the more stringent requirement shall be met.

#### 1.3 CONTRACTOR SUBMITTALS



A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

1. Shop Drawings. Shop drawings and design calculations shall be submitted showing details of construction and layouts for review and acceptance before materials are fabricated.
2. Product Data. Submit manufacturer's printed literature for care and maintenance for review and acceptance, including certification the manufacturer has at least five years of experience in the fabrication and supply of circular dual drain aquaculture tanks of the size specified.
3. CONTRACTOR shall provide color samples of a standard color palette for OWNER selection and approval.
4. Submit final inspection and approval prior to shipment.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Tanks and accessories shall be delivered and placed without damage.

#### 1.5 WARRANTY

A. **All Components:** The Manufacturer shall furnish to the CONTRACTOR the Manufacturer standard 1-year workmanship warranty, commencing on the date of successful commissioning at the Project by the OWNER, through the CONTRACTOR.

### PART 2 -- PRODUCTS

#### 2.1 REQUIREMENTS

A. Manufacturers' Qualifications

1. Only manufacturers with 5 years or more of proven experience and satisfactory performance in the manufacture of fiberglass reinforced plastic fish tanks.
2. All manufacturers shall be required to submit a complete set of design calculations, material specifications and shop drawings.

B. Description of Fiberglass Fish Feeding Vessel

1. Provide fiber-reinforced plastic tanks complete and ready for piping hookup and installation in the size indicated in Section 1.1.B.1. The tanks are to be used for the production of fish in water temperatures ranging from 0 to 20 degrees Celsius. The tanks are to be used for an interior, covered application as shown on the Drawings but may be subjected to the maximum ambient temperature range and fluctuations for the geographical location in the event of a facility shut-down.
2. Tanks shall conform to all dimensions and have the features indicated on the Drawings. CONTRACTOR shall verify tank dimensions and resolve any spacing

changes required prior to installation. Units to be provided with reinforcement sufficient to maintain less than 1/2" total deflection at midpoint when filled with water.

3. Tank standpipe opening and screen slots shall be fabricated for use as shown on the Drawings.
4. All tank drain standpipes shall be provided by the tank manufacturer. Standpipes shall seat in a molded PVC pipe coupling where shown in the Drawings to provide watertight seal at base.
6. Each tank shall be provided with screen slots to fit existing fish screens 6'-0 3/8" wide, 4'-4" tall, and 1 1/2" thick.

## 2.2 WORKMANSHIP

- A. **Visual Defects:** ASTM D 2563 shall be used for quality control of both filament-wound and hand lay-up construction. Acceptance levels shall be as follows:

<u>Process Surface:</u>	<u>Defects:</u>
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Dry Spots	None
Entrapped Air	None at surface. If in laminate 1/16-in dia max and 5/sq. in max.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/8-in dia X 1/32-in deep, max 10/sq. ft.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness.
Sharp Discontinuity	None

<u>Non-Process Surface:</u>	<u>Defects:</u>
Blisters	Max 1/4-in X dia 1/16-in high.
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall.
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq. in/sq. ft
Entrapped Air	1/8-in dia max; no more than 3 percent of area.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate.
Pits	Max 1/8-in dia X 1/16-in deep.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in.
Sharp Discontinuity	None

- B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas shall be repaired and re-inspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.
- C. **Shop Inspection:** The OWNER or OWNER Representative shall be permitted access to the manufacturing area during fabrication and shall be notified one week prior to the estimated date of tests and/or inspections. Final inspection and approval shall be obtained prior to shipment unless written waiver is obtained. The shop inspection of the equipment shall include the following:
  - 1. Check for compliance with Drawing dimensions and adherence to construction standards.
  - 2. An acetone wipe test to check surface cure. No surface tackiness is permitted.
  - 3. A Barcol hardness test; at least 90 percent of manufacturer's specified hardness must be attained.
  - 4. Examination of laminated (nozzle) cutouts.
  - 5. A hydrotest of at least 24 hours duration to check for leaks.

## 2.3 BOLTS, ANCHOR BOLTS, WASHERS, SUPPORTS, AND HOLD DOWN LUGS

- A. The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the plastic and fiber glass items in this Section and in accordance with the requirements of the manufacturers of the plastic and fiber glass items. Bolts, anchor bolts, washers, hold down lugs, and supports required in connection with the plastic or fiberglass items shall be of Type 316 stainless steel.

## PART 3 -- EXECUTION

### 3.1 TANK INSTALLATION AND DELIVERY

- A. The fiberglass tank manufacturer shall review and certify in writing that all installation requirements as shown on the plans are in accordance with design character and limitations of the unit.
- B. The tanks shall be covered and protected to prevent damage in shipment and handling. All finished surfaces are to be protected. Tanks shall not be stored in the open at manufacturer's site or at job site. Any damage to the units incurred in transit and unloading shall be the responsibility of the manufacturer. Permits, import requirements, and precautionary measures required for highway transport are the entire responsibility of the manufacturer.
- C. The manufacturer shall be responsible for delivering and supervising the unloading of the units at the hatchery. Visually imperfect units shall be rejected. The manufacturer and CONTRACTOR shall fully cooperate in the unloading and installation of the units at the hatchery.

- D. The manufacturer shall fully cooperate and shall assist the CONTRACTOR with respect to the tank shipping and loading/unloading schedule. The shipping schedule shall conform to the project completion schedule.
- E. The manufacturer shall provide a qualified site representative with the first shipment of units to the project site to insure proper unloading, handling and final installation. The CONTRACTOR shall provide equipment to handle and install the tanks in strict accordance with the manufacturer's instructions.
- F. The manufacturer shall provide a qualified site representative during installation of the units to verify proper installation and grading of the tank bedding material, verify proper tank installation, and connections to the process piping.
- G. The manufacturer shall provide a qualified site representative during start up and commissioning to provide guidance to the CONTRACTOR and to provide training to Hatchery personnel on the correct operation of the tanks including start up procedures, operational procedures, and end of season draining procedures.
- H. All minor defects shall be refinished by the manufacturer prior to completion of the Project and acceptance by the OWNER. The refinished surface shall show no discernible variations in appearance from the surrounding areas.
- I. Prior to shipment, the tanks shall be cleaned to remove any residual parting agent, film or other deleterious material. The units shall be carefully cleaned (per the manufacturer's instructions) prior to completion of the project.
- J. The first tank manufactured shall be inspected by the OWNER and the CONTRACTOR for conformance to drawings and specifications prior to manufacturing remaining order. All subsequent tanks shall be inspected by the CONTRACTOR prior to shipment to the site.

- END OF SECTION -

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## SECTION 13 34 19 - PRE-ENGINEERED METAL BUILDING SYSTEMS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall furnish and install all components, materials and sub-assemblies, and all appurtenant work to construct the pre-engineered metal building (PEMB) system, complete as defined in this specification, and in accordance with the requirements of the Contract Documents.
- B. The CONTRACTOR shall submit documents from the Metal Building System Supplier (MBSS) as identified by this Section to the ENGINEER for approval of the PEMB, prior to the installation of the PEMB.

#### 1.2 WORK INCLUDED

- A. Pre-engineered metal building(s) as shown on Contract Document shall be furnished by the MBSS complete with, but not limited to, the following:
  - 1. Complete engineering design of the building system per the requirements of Part 1.5 below.
  - 2. Primary and secondary steel framing including frames, purlins, girts, and flange bracing.
  - 3. Pre-finished roof and wall cladding, including liner panels if required, and associated trim, mastic, and closures, including gutters and downspouts.
  - 4. Diagonal bracing.
  - 5. Framed openings including overhead and walk door frames.
  - 6. Skylights, translucent panels and other roof and wall opening accessories, including penetration flashing, as shown on the Contract Drawings.
  - 7. Fasteners.
  - 8. Overhead doors and walk doors.
  - 9. Insulation and vapor barriers.
  - 10. All other components and materials as required for a complete and weather tight installation.

#### 1.3 DESCRIPTIONS

- A. **Building Type:** Rigid frame with column and rafter sections of shop welded steel plates; allowed to be tapered unless noted otherwise by the Contract Drawings. The frames shall be:

1. Gable, as shown on the Contract Drawings,
  2. Either clear span or multi-span using interior columns, adopting the configuration shown on the frame sections for each PEMB in the Contract Drawings.
- B. **Building Height and Roof Slope:** Either of the following two methods will determine the height of the structure. If case (2) defined below is not explicitly defined on the Contract Drawings or Specifications, then case (1) applies:
1. **Eave Height as shown on Contract Drawings:** The eave height shall be defined as the height corresponding to the top of the purlin cavity at the outside-of-girt location (high side, if the building is monoslope). By this definition the eave height excludes the thickness of the roof panel and is unaffected by eave extensions, per industry standard.
  2. **Eave defined by an Inside Clearance:** If this approach is indicated in either the Contract Drawings or the Specifications, the eave of the building shown on the Contract Drawings will be estimated, with the inside clearance at the Haunch of the lowest Rigid Frame governing.
- C. **Column Spacing at Exterior Walls:** As shown on Contract Drawings and compatible with placement of wall openings (walk doors, overhead doors, etc.) and other requirements.

#### 1.4 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

All references listed herein shall be the most current version.

##### A. **Commercial Standards:**

AISC	American Institute of Steel Construction, "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 bolts."
AISC 360	American Institute of Steel Construction, "Steel Construction Manual" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings."
AISC 341	American Institute of Steel Construction, "Seismic Provisions for Structural Steel Buildings."
AISI	American Iron and Steel Institute, "Specifications for the Design of Cold Formed Steel Structural Members."
ANSI A 320.9	Voluntary Specifications for Aluminum Prime Windows.
ANSI A 115	Specifications for Door and Frame Preparation for Hardware.
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

ASTM A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 653	Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792	Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
ASTM A 924	Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
ASTM A 1008	Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A 1008	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM F 1554	Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
AWS D1.1	American Welding Society: "Structural Welding Code-Steel."
AWS	American Welding Society: "Standard Code for Arc and Gas Welding in Building Construction."
FGMA	Flat Glass Marketing Association, "Glazing Manual."
CBC	CBC California Building Code
ICC	IBC International Building Code
ICC	IFC International Fire Code



MBMA	Metal Building Manufacturers Association, "Design Practices Manual."
MBMA	Metal Building Manufacturers Association, "Low-Rise Building Systems Manual."
MBMA	Metal Building Manufacturers Association, "Metal Building Systems Manual."
NFPA	National Fire Protection Association
OSHA	OSHA Regulations
SSPC	Structural Steel Painting Council, applicable standards, as referenced herein.
TT-P	Federal Specification, applicable standards, as referenced herein

## 1.5 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. **Shop Drawings and Calculations** shall include:

1. Design Calculations and Erection Drawings: The final shop drawing corrected calculations and drawings shall be sealed by a Registered Professional Engineer, licensed to practice in the State which the building is to be constructed, and shall be submitted by the MBSS to the CONTRACTOR & OWNER for their final record and review. If computer programs are utilized in the preparation of calculations, the program's operational premise shall be submitted along with the output data.
2. Shop drawings shall show each type of structural building frame required and its location within the structure. All flange braces required shall be readily identifiable on the shop drawings. All details and other pertinent information required for proper and complete fabrication, assembly and erection of a watertight metal building system shall be provided. Drawings shall show sealant locations.
3. Elevation drawings shall be provided for each of the exterior wall systems, including location of all non-field-located framed openings. Details showing necessary block-outs for the framed openings shall also be provided.
4. Calculations and details of anchorage, including anchor bolt size, grade, location, and embedment length, shall be by the MBSS and shall be submitted for review.
5. Rigid-frame cross-sections shall be provided showing the vertical and horizontal inside clearances.
6. Shop drawings and calculations include the placement and setting details of the cast-in-place anchor bolts, including minimum requirements for bolt material strength, diameter, and projection, the location, magnitude and direction of all loads imposed on the foundation system."

C. **Schedule:** The MBSS shall submit a complete schedule of fabrication and delivery to the site of the pre-engineered building. The CONTRACTOR shall also furnish a schedule detailing sequencing of erection of the pre-engineered building and clearly define the relationship of work of this Section to the overall project schedule.

D. **Material and Color Samples:**

1. Color and texture sample sets shall be submitted by the CONTRACTOR of the full range of alternatives available for selection by the OWNER. The samples shall be clearly marked to show the paint manufacturer's name and product identification.
2. 12-inch square of roof and wall panels, with required finishes.
3. Fasteners for roof and wall panels.
4. Samples of the selected trim color, roof and wall color shall be submitted after color selection.

E. **Erection and Maintenance Manual:** The MBSS's complete building system description, erection manual and maintenance instructions shall be submitted by the CONTRACTOR.

F. **Certificates:**

1. Building engineer & fabricator's certification shall be submitted, prepared and signed by a Registered Professional Engineer licensed to practice in the State which the building is to be constructed, attesting that the building design meets all specified system performance design criteria and the requirements of applicable codes and authorities having jurisdiction at the project site.
2. Documentation shall be submitted by the MBSS and CONTRACTOR confirming that the roof system qualifies for the Underwriters Laboratories Class 90 rating.

## 1.6 QUALITY ASSURANCE

A. **Design Criteria**

1. **Structural Steel:** For the design of structural steel members, comply with the requirements of the American Institute of Steel Construction (AISC) 360 "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" and AISC 341.
2. **Light Gauge Steel:** For the design of light gauge steel members, comply with the requirements of the American Iron and Steel Institutes (AISI) "Specification for the Design of Cold Formed Steel Structural Members" and "Design of Light Gauge Steel Diaphragms".
  - a. For welded procedures, comply with the American Welding Society (AWS) "Standard Code for Arc and Gas Welding in Building Construction".

## 1.7 SYSTEM PERFORMANCE & DESIGN LOADINGS

A. Notwithstanding any statement in the Contract, the pre-engineered metal buildings shall be designed to satisfy at a minimum the provisions of the California Building Code with

Siskiyou County Amendments. Minimum load criteria shall comply with the requirements of ASCE 7 and the parameters and loads described in the following sections.

**B. Risk Category:**

1. Risk Category = II

**C. Wind Condition Design Loadings:**

1. Ultimate Wind Speed,  $V_{ult} = 115$  MPH
2. Exposure = C
3. Internal Pressure Coefficient (G) = +/- 0.55 (Partially Enclosed)
4. Topographic Factor,  $K_{zt} = 1.00$

**D. Seismic Condition Design Loadings:**

1. Mapped Spectral Response Acceleration,  $S_s = 0.584$
2. Mapped Spectral Response Coefficient,  $S_1 = 0.304$
3. Site Class = D
4. Importance Factor,  $I_e = 1.00$
5.  $C_s$  shall be calculated in accordance with Eqn. 12.8-2.

**E. Vertical Live Loads:**

1. Purlins and Roof Joists: Design for 20 PSF (live load) uniformly distributed over supported roof area. The live load for these elements shall not be reduced.
2. Primary Framing (Frames): Design for 20 PSF (live load) uniformly distributed over supported roof area, unless permitted to be reduced in accordance with provisions of IBC or ASCE 7.
3. Roof Covering: Design to support either a 20 PSF uniformly distributed load or a 300-lbs. concentrated load over a 1-ft x 1-ft area located at center of maximum roof panel span. The most severe loading condition shall govern the design.
4. Snow Load: 58 psf ground snow ( $P_g$ ). **Minimum uniform (blanket) roof snow load as defined by the local building official or State shall be designed for, and it is the responsibility of the MBSS to confirm if one exists by contacting the local building official.** Snow drift loads shall be taken into consideration for roof snow load, including those from parapets and roof top obstructions. Sliding snow provisions shall not be used when in conjunction with snow guards designed to prevent snow from sliding.
5. Snow Importance Factor,  $I_s = 1.00$

**F. Dead Loads:**

1. Dead loads for the building shall include the weight of all materials of construction incorporated into the building including fixed service equipment.

**G. Collateral Loads:**

1. In addition to dead loads, the building shall be designed for a minimum of **3 psf** throughout the roof to account for miscellaneous mechanical and electrical equipment loads. These loads shall be used with gravity load cases, but not used for uplift wind and seismic cases, to produce the worst possible loading scenario.

**H. Deflections:** Deflection (D) of structural elements and cladding shall not exceed the following, where H is the height from the member to the bottom of the eave, and L is the length of the unsupported clear span of the respective member:

1. Sidesway of Rigid Frames:

b. Non-Seismic Cases:  $D < H/90$ , Seismic Cases:  $D < H/60$ ;

c. Portal Frames/Wind Bents for Wind:  $D < H/90$ ;

2. Sidesway of Braced Frames:  $D < H/90$ ;

3. Vertical Deflection of Rigid Frame Rafters:  $D < L/180$ ;

4. Vertical Deflection of Endwall Rafters:

a. Wind cases:  $D < L/120$ ;

b. Live load cases:  $D < L/180$ ;

5. Endwall and Soldier Columns:  $D < L/120$ ;

6. Purlins:

a. Wind cases:  $D < L/120$ ;

b. Live load cases (including snow):  $D < L/180$

c. Purlins in eave extensions for both live and wind cases:  $D < L/90$ .

7. Girts:

a. Not supporting masonry or concrete walls or glass:  $D < L/90$

8. Panels / Cladding:  $D < L/90$ .

- I. Design temperature differential shall be a minimum of 120 degrees F for thermal expansion and contraction analysis of framing systems. Standing Seam Roof Systems in large roof areas shall have thermal expansion and contraction accounted for in the design.

- J. **Purlin Roll.** Purlins shall be designed to prevent purlin roll resulting from heavy snow loads acting on steep roof pitches with larger sidewall bay spacing.

## K. Girts and Other Secondary Steel Requirements:

1. Vertical spacing between horizontal girts shall be as determined by system design.
2. MBSS shall design the secondary steel to accommodate all framed openings. Additional strength shall be provided as required for roll-up doors. Additional channels shall be provided for overhead doors to support full vertical travel of overhead doors.

## 1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. **Delivery of Materials:** Manufactured materials and prefabricated components shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the building engineer & fabricator.
- B. **Storage:** All materials shall be carefully stored in conformance with the building engineer & fabricator's recommendations, on platforms or pallets above grade or on concrete slab, covered with opaque tarpaulins or other approved weather-resistant ventilated covering. Storage shall be in a manner that will prevent damage or marring of finish.
- C. **Trapped Water:** Efforts shall be taken to transport and store structural members in a manner which prevents them from collecting rainwater (ex: uncovered rigid frames on their side). Any additional cost required to remove water from structural members shall be paid by the CONTRACTOR.

## 1.9 WARRANTY

- A. **All Components:** The MBSS shall furnish to the CONTRACTOR the MBSS's standard 1-year workmanship warranty, commencing on the date of acceptance of the Project to the OWNER, through the CONTRACTOR.
- B. **Roof Cladding:** MBSS shall provide standard 10-year paint finish warranty and standard 20-year no-perforation warranty to the OWNER, through the CONTRACTOR.
- C. **Wall Cladding:** MBSS shall provide standard 10-year paint finish warranty to the OWNER, through the CONTRACTOR.

## PART 2 -- PRODUCTS

### 2.1 STRUCTURAL STEEL

#### A. Materials

1. Structural Plate or Bar Stock: ASTM A572 Gr. 50 or 55.
2. Cold Formed Structural Steel: Minimum yield strength (Fy) of 55,000 PSI.
3. Structural steel angles and misc. plates: ASTM A36 or ASTM A572 Gr. 50.
4. HSS (Square, Rectangular, Round): ASTM A500 Gr. B.
5. Primary Structural Bolts and Nuts: ASTM A325.

6. Secondary Structural Bolts and Nuts: ASTM A325.

## B. Primary Structural Steel

1. Columns and Rafters: Fabricated with all necessary holes for attachment of secondary members and flange braces.
2. Rigid Frame End Plates: Factory fabricated for precision for all rafter-to-rafter and/or column-to-rafter connections, complete with connection bolt holes. **Holes in the column base plate that align with cast-in-place anchor rods shall be sized to match the recommended sizes for anchor rod holes in base plates per the AISC Manual of Steel Construction to accommodate concrete construction tolerances.**
3. Base Plates, End Plates, and Stiffeners: Factory welded to primary steel elements.
4. Join flanges and webs of structural members fabricated of plate or bar stock together by continuous automatic submerged arc welding process with all welding performed under the supervision of certified welders in accordance with standard practices of AWS D1.1.
5. Coating:
  - a. **Coating:** All primary structural steel shall be **hot-dipped galvanized** to meet standards, at a minimum, of ASTM A123.
  - b. The steel shall have the necessary surface preparation performed (either at the fabrication shop or the galvanizing facility, or both) to produce a product free of surface discontinuities which would be removed during the SP3 "*Power Cleaning*" definition of surface preparation.
  - c. Steel members shall be fabricated with drain holes and/or details as required by the galvanizer to galvanize the product safely, without incurring **zinc bath explosion**.

## C. Secondary Structural Steel:

1. Purlins: Provide Z sections, roll formed, punched for attachment with minimum 1/2-inch diameter bolts. Purlins on roof system shall be spaced at no greater than 5.0 feet on center.
2. Girts: Provide roll formed Z sections; or C sections either roll or break formed, punched for attachment with minimum 1/2-inch diameter bolts.
3. Eave Struts: Cold formed sections with minimum (Fy) 55,000 PSI steel, with vertical web to receive sidewall panels and two 1/2-inch-diameter bolt attachments to rigid frame in factory-punched holes in column or bracket.
4. Roof Struts: Provide as required with attachment to top flange of rigid frame rafters by two of 1/2-inch minimum size diameter bolts at each end of strut.
5. **Base Channel: 14 Gauge.**

6. Flange Braces: Steel angles attached to purlin or girt, to stiffen rigid frame flanges as dictated by the MBSS and noted on final shop drawings.

7. Coating:

- a. Secondary structural steel members (purlins, girts, struts, braces, etc.) shall be coated with **G90 Galvanizing**, meeting ASTM A653.

## 2.2 EXTERIOR ROOF PANELS

- A. Exterior roof panels shall comply with Section 07 41 16 – Insulated Metal Roof Panels.

## 2.3 EXTERIOR WALL PANELS

- A. Exterior wall panels shall comply with Section 07 42 13.19 – Exterior Wall Panels

## 2.4 FLASHING AND TRIM

- A. Flashing and trim shall comply with Section 07 62 00 – Sheet Metal Flashing and Trim

## 2.5 SNOW GUARDS

- A. Snow guards shall comply with Section 07 72 53 – Snow Guards.

## 2.6 JOINT SEALANTS

- A. Joint sealants shall comply with Section 07 92 00 – Joint Sealants.

## 2.7 OVERHEAD COILING DOORS

- A. Overhead coiling doors shall comply with Section 08 33 23 – Overhead Coiling Doors.

## 2.8 SECTIONAL DOORS

- A. Sectional doors shall comply with Section 08 36 13 – Sectional Doors.

## 2.9 OTHER WALKDOORS AND FRAMES

- A. Hollow metal doors and frames shall comply with Section 08 11 13 – Hollow Metal Doors and Frames.

## 2.10 DOOR HARDWARE

- A. Door hardware shall comply with Section 08 71 00 – Door Hardware.

## 2.11 UNIT SKYLIGHTS

- A. Unit skylights shall comply with Section 08 62 00 – Unit Skylights.

## 2.12 LOUVERS

- A. Operable wall louvers shall comply with Section 08 91 16 – Operable Wall Louvers.

- B. Fixed louvers shall comply with Section 08 91 19 – Fixed Louvers.

## 2.13 WIND AND SEISMIC BRACING

- A. Tension-only cable or rod bracing shall be used for lateral wind and seismic bracing. Braces shall be located to avoid framed openings, unless accepted by the OWNER. Braces shall have all necessary connection materials provided.

## 2.14 ACCEPTABLE METAL BUILDING SYSTEM SUPPLIERS

- A. Subject to compliance with specified requirements, the following are acceptable MBSS suppliers:
  - 1. Evergreen Industrial. Ltd.;
  - 2. American Buildings Company;
  - 3. Or approved equal.

## PART 3 -- EXECUTION

### 3.1 ERECTION

#### A. General

- 1. **Erector's Qualifications:** The CONTRACTOR shall erect the prefabricated building, or have the erection performed by a Subcontractor under their supervision. The party which erects the PEMB shall have not less than 5 years successful experience in the erection of prefabricated buildings similar to that required for this project.
- 2. Metal building system components shall be installed in strict compliance with the MBSS instructions shown on final shop drawings.
- 3. Handle and store all materials to avoid damage and replace any damaged materials.
- 4. The party which erects the PEMB shall observe and follow recommendations of the Metal Building Manufacturers Association (MBMA) practice and procedures where applicable and the recommendations of the MBSS.
- 5. The party which erects the PEMB shall not field cut or alter primary or secondary structural members without approval from the Engineer of Record.
- 6. A minimum of 1-inch of non-shrink, non-metallic grout shall be provided under each column base plate.

#### B. Structural Frames

- 1. Structural frames shall be erected true to line, level and plumb, **braced and secured with temporary bracing** in all directions as required.
- 2. Base plates shall be leveled and secured with anchor bolts to a level plane with full bearing on foundation supporting structures. **A minimum of 1-inch grout shall be used under base plates.**



### **C. Bracing**

1. All permanent bracing shall be installed in appropriate roof and sidewall locations as indicated on approved shop drawings. Sidewall knee braces, if knee braces are used, shall be located within 5-feet from the top of the building columns.

### **D. Framed Openings**

1. Securely attach to building structural framing members, square and plumb.

### **E. Roof and Wall Panels:**

#### **1. General**

- a. Install roof and canopy panels in such a manner to permit drainage to eaves of building, with panel ends square to eave.
- b. Install wall panels with vertical edges plumb.
- c. Arrange and nest side lap joints away from prevailing winds when possible.
- d. Apply panels and associated items for neat and weather-tight enclosure.
- e. Avoid "panel creep" or application not true to grid lines.
- f. Protect factory finishes from mechanical damage or abrasions.
- g. Install approved type closures to exclude weather.
  - i. Install weather seal under ridge cap. Flash and seal roof panels at eave, gable and perimeter of all openings through roof and elsewhere as required or shown on Contract Drawings.
  - ii. Flash and/or seal wall and liner panels at perimeter of all openings, under eaves and gable trims, along lower panel edges, and elsewhere as required or shown on Contract Drawings, as applicable.
- h. Remove all fastener or cutting shavings from roof and wall as erection is completed.

#### **2. Wall Panels**

- a. Align bottoms of panels to proper coverage and fasten with panel manufacturer's recommended and supplied fasteners.
- b. Cut and fasten flashing and trims with approved type fasteners.
- c. Install all fasteners with power tool having adequate torque and proper RPM adjusted to seat fastener without damage to heads, washers or panels.
- d. Install panel side lap away from prevailing wind or view direction when possible, maintaining proper lap without fastener dimpling or excessive overlap.

3. **Accessories:** Install flashings, trim, ridge covers, roof curbs, skylights, pipe flashings, closure strips, roof jacks, gutters, roof drains, Insulation, and other accessories and sheet metal items in accordance with manufacturer's recommendations for positive attachment to building and provide a weathertight mounting.

F. **Overhead Doors:** The doors, tracks, hardware, and accessories shall be installed in accordance with door manufacturer's instructions and as shown on Drawings for fully operational door system. The party installing the overhead doors shall be an authorized distributor of the door manufacturer.

### 3.2 COATINGS

A. All abrasions, scratches, field welds or other damages in shop-primed or factory-finished painted surfaces shall be touched-up consistent with the quality and coating thickness of original shop primer or factory-finished painting. In the case of hot-dip galvanizing, a similar quality of touch-up galvanizing shall be applied to the aforementioned damages.

B. When paint is used, finish coats shall be provided which are compatible with the metal building engineer & fabricator's prime coat paints.

C. When paint is used, Hardware, accessories and similar items not intended to be finish-painted shall be properly protected during painting operations.

### 3.3 FIELD QUALITY CONTROL

A. All framing members shall be erected plumb, level or aligned not to exceed a deviation 1:300 (i.e., no more than 1-inch in 25-ft)

B. The ENGINEER shall make at least one (1) on-site inspection during the erection and installation of the building as required ensuring that erection is in accordance with the MBSS's and ENGINEER's foundation design requirements.

C. The CONTRACTOR shall provide written certification that the final installation has been erected in conformance with the MBSS recommendation and meets the requirements of the Specifications.

- END OF SECTION -

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## SECTION 13 50 00 – PREDATOR NETTING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide predator netting in conformance with the Contract Drawings.
- B. This specification is based on the 1.5" x 1.5" 380/21ply (US#15) DuraTough netting as manufactured by Pacific Netting Products.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Detailed plans for the fabrication and erection of predator netting shall be submitted for review by the ENGINEER.
- C. **Netting Calculations:** Detailed calculations stamped by a licensed professional engineer showing that the predator netting is capable of withstanding the design loads shall be submitted for review by the ENGINEER.
- D. Product data sheets shall be submitted for review by the ENGINEER.

### PART 2 -- PRODUCTS

#### 2.1 Predator Netting

- A. The predator netting shall be comprised of black twisted knotted polyethylene conforming to the following;
  - 1. Mesh size – 1.5" x 1.5"
  - 2. Twine diameter – 1.54 mm
  - 3. Mesh break minimum strength – 100 lbs per ISO 1806
  - 4. Minimum burst strength per square foot – 839 lbs
  - 5. Color – Black
  - 6. Construction – Twisted knotted
  - 7. Finish – UV stabilized and bonded, suitable for outdoor exposure
- B. Design Requirements
  - 1. Roof snow load – 40 psf

2. Design wind speed – 115 mph
3. Mesh size must limit birds from penetrating the netting, namely kingfishers.

### **PART 3 -- EXECUTION**

-- Not used --

- END OF SECTION -

## **SECTION 13 60 01 – OUTDOOR VAULT TOILETS**

### **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 SUMMARY**

- A. The CONTRACTOR shall furnish and install all components, materials and sub-assemblies, and all appurtenant work to construct the precast outdoor vault toilet, complete as defined in this specification, and in accordance with the requirements of the Contract Documents.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: Submit manufacturer's product data.
- B. Shop Drawings: Submit shop drawings including profiles, accessories, location, adjacent construction interface, and dimensions, stamped by a Licensed Professional Engineer.
- C. Warranty: Submit executed copy of manufacturer's standard warranty.
- D. Calculations: Submit detailed calculations stamped by a Licensed Professional Engineer.

#### **1.4 MANUFACTURER CRITERIA**

- A. The manufacturer supplying the requested precast concrete vault toilet facility must meet the following;
  - 1. ISO 9001 certified
  - 2. PCI certified
  - 3. Gunnison style vault toilet by CXT Incorporated, or approved equal

#### **1.5 Warranty**

- A. Manufacturer shall provide a one (1) year warranty.

#### **1.6 Design Criteria**

- A. The design shall meet all applicable accessibility and building code requirements.
- B. Vault toilet shall be designed to meet the Project general design load criteria on sheet GS001 of the contract drawings, plus the following additional criteria;

1. Sweet Smelling Technology (SST)
  - a) Vault building shall incorporate design aspects of SST as outlined by Briar Cook for the U.S. Forest Service
  - b) All wall to floor interior surface seams shall have a minimum 1" radius coving made of high strength grout
  - c) The vault shall have a bottom slope of 1" per foot from under the toilet riser out to the outside cleanout area.
  - d) The vault shall have a 24" diameter (minimum) lightweight manhole cover installed to the rear or side of the building.
  - e) The manhole cover should be raised, with the surrounding concrete sloped away using a minimum slope of 1/2" per foot.
  - f) The depth of the vault shall be no deeper than 4 1/2' to 5'.
  - g) A 12" diameter round pipe shall be installed to vent the vault and the pipe shall be raised a minimum of 3' above the highest point of the roof. Vent pipe shall be straight up from the vault.
  - h) There shall be only one vent opening in the building and it shall be placed only on one side of the building (the side that the wind blows against).
2. All concrete design with a minimum 7/12 roof pitch.
3. Minimum 4" wall, 4 1/2" roof, and 5" floor thickness
4. One-piece floor unit
5. One-piece full length and width vault unit

## PART 2 -- PRODUCTS

### 2.1 Materials

#### A. Concrete – General

1. The concrete mix design shall be designed to ACI 211.1 to produce concrete of good workability.
2. Concrete shall contain a minimum of 675 pounds of cementitious material per yard.
3. Cement shall be a low alkali type I/II or III conforming to ASTM C-150.
4. Coarse aggregates used in the concrete mix design shall conform to ASTM C33 with the designated size of coarse aggregate #67.
5. Maximum water/cement ratio shall not exceed .45.

6. Air-entraining admixtures shall conform to ASTM C260. Water reducing admixtures shall conform to ASTM C494, Type A.
7. If Self Compacting Concrete (SCC) is used, it must conform to ASTM C1611.

B. Concrete – Cold Weather

1. Cold weather concrete placement shall be in accordance with ACI 306.
2. Concrete shall not be placed if ambient temperature is expected to be below 35°F during the curing period unless heat is readily available to maintain the temperature of the concrete at least 50°F.
3. Materials containing frost or lumps of frozen materials shall not be used.

C. Concrete – Hot Weather

1. The temperature of the concrete shall not exceed 90°F at the time of placement. When the ambient reaches 90°F the concrete shall be protected with moist covering.

D. Concrete Reinforcement

1. Reinforcing steel shall conform to the requirements of Specification 03 20 00.

E. Caulking, Grout, Adhesive and Sealer

1. Caulking service temperatures from -40°F to +194°F.
2. Interior and exterior joints shall be caulked with a paintable polyurethane sealant.
3. Grout shall be a non-shrink type and shall be painted to match the color of surrounding concrete as nearly as possible.
4. Cement base coating shall be formulated with a very fine aggregate system.

F. Dead Bolt

1. Certified ANSI/BHMA A156.5-2001 Grade 1.
2. Heavy duty tamper resistant.
3. 2¾" backset.
4. U.S. 26D finish.

G. Doors – Steel

1. Doors shall be flush panel type 1¾" thick, minimum 16-gauge galvanized steel, top painted with DTM ALKYD.
2. Door frames shall be knockdown or welded type, single rabbet, minimum 16-gauge prime coated steel top painted with DTM ALKYD, width to suit wall thickness.
3. Three (3) rubber door silencers shall be provided on latch side of frame.



#### H. Door Hinges

1. Three (3) per door with dull chrome plating 4½" x 4½", adjustable tension, and automatic closing for each door.

#### I. Doorstop

1. Dome style stop meeting ANSI 156.16.

#### J. Door Sweep

1. Provided at the bottom of door with an adjustable brush.

#### K. Double Coat Hook

1. 16-gauge (1.5mm), type 304 stainless steel.
2. Formed construction with a satin finish and 3<sub>16</sub>" x 7<sub>8</sub>" nail in anchor.
3. Upper hook shall extend at least 2½" from the wall.
4. Lower hook shall extend at least 1¼" from the wall.

#### L. Grab Bars

1. 18-gauge, type 304 stainless steel with 1½" clearance.
2. Able to withstand 300-pound top loading.

#### M. Lockset

1. Meets ANSI A156.2 Series 4000, Grade 1 cylindrical lockset for exterior door.
2. Lever handle both inside and out.
3. Either handle operates latch unless outside handle is locked by inside push-button.
4. Push-button shall automatically release when inside lever handle is turned or door is closed.
5. Emergency slot on exterior so door can be unlocked from the outside with a coin, screwdriver etc.
6. Inside lever always active.
7. U.S. 26D finish.

#### N. Paint

1. Paints shall not contain more than .06% by weight of lead.
2. Inside concrete surfaces.
  - a) Interior floors – chemical resistant urethane, color gray.

- b) Interior walls and ceilings – modified acrylic, water repellent penetrating stain, color white followed by a clear acrylic anti-graffiti sealer.
- 3. Exterior concrete surfaces.
  - a) Exterior slab – clear sealer.
  - b) Exterior walls and roof – water repellent penetrating stain in the same color as the walls or roof followed by a clear acrylic anti-graffiti sealer.
  - c) Metal surfaces (interior and exterior) - DTM ALKYD or approved equal.

O. Riser

- 1. Meets ADA standards.
- 2. Molded one-piece HDPE polyethylene.
- 3. Smooth surface and high impact resistance at extremely cold temperatures.

P. Sealers and Curing Compounds

- 1. Curing compounds, if used, shall be colorless, complying with ASTM C309, type I or 1-D.
- 2. Weatherproofing sealer for exterior of building shall be clear water repellent penetrating sealer.

Q. Signs

- 1. Signs to have raised pictograms, letters, and braille to meet ADA requirements.
- 2. Interior to have “No Trash in Vault” sign.
- 3. All signs shall be inset a minimum of  $\frac{3}{4}$ ” into wall with 45-degree bevel.
- 4. All signs shall be anchored into concrete with  $\frac{1}{4}$ ” x  $\frac{3}{4}$ ” concrete anchor nails.

R. Toilet Paper Dispenser

- 1. Constructed of  $\frac{1}{4}$ ” thick, type 304 stainless steel.
- 2. Holds three (3) standard rolls of toilet paper.
- 3. Fastening system able to withstand 300-pound top loading.

S. Polyethylene Vault Liner

- 1. Shall consist of a Roto molded 8460 polyethylene.
- 2. Holds up to 1,000 gallons of waste or 15,000 uses per vault.
- 3. Minimum thickness 0.10”.

4. Molded dovetail embeds to attach the liner to concrete walls of the vault.
5. Welded two (2) C-channels to attach the liner to the bottom of the vault.

T. Vent Stack

1. Minimum 12" in diameter and a minimum 3' higher than the roof peak.

U. Wall Vent

1. Vent cover shall be 14-gauge, type 304 stainless steel painted with DTM and anchored into the concrete wall with high strength anti-rust tap con fasteners.
2. Vent louver frame and louvers shall be non-vision, 0.1" extruded, aluminum jet coat finish.
3. Vent shall have insect screen.
4. Cover to be recessed a minimum  $\frac{3}{4}$ " on exterior walls with a 45-degree bevel. Interior to be flush mounted. Wall vent shall not protrude from the wall.

V. Windows and Vault Cleanout Cover

1. Windows and cleanout cover frames shall be constructed from steel.
2. Window glazing shall be  $\frac{3}{16}$ " thick translucent pebble finished mar-resistant Lexan.
3. Plate for vault cleanout cover shall be  $\frac{1}{4}$ " thick diamond plate steel.
4. Lid shall be hinged and configured so that it can be locked with a padlock. A gasket shall be provided around the entire perimeter of the lid to provide an airtight seal.
5. Windows shall have  $\frac{3}{4}$ " recess with 45-degree bevel.
6. Windows frames shall have vandal resistant fasteners.

W. Bedding Materials

1. Bedding material shall be sand or  $\frac{3}{8}$ " minus crushed or screened aggregate.

X. Caulking

1. Caulking between vault and toilet floor shall be 1" x 1" Butyl tape designed specifically to bond precast concrete to precast concrete.

## PART 3 -- EXECUTION

### 3.1 Fabrication

A. Mixing and Delivery of Concrete

1. Mixing and delivery of concrete shall be accordance with ASTM C94, Section 12.6 through 12.9.

#### B. Placing and Consolidating Concrete

1. Concrete shall be consolidated by the use of mechanical vibrators. Vibration shall be sufficient to accomplish compaction but not to the point that segregation occurs.

#### C. Finishing Concrete

1. Interior floor and exterior slabs shall be floated and troweled.
2. All exterior building walls and exterior screen walls texturing shall be selected by OWNER.
3. All exterior surface textures of the roof panels shall be selected by the OWNER. The underside of the overhang shall have a smooth finish.

#### D. Repairs

1. Cracks in concrete components which shall be determined to affect the structural integrity of the building shall be rejected.
2. Small holes, depressions, and air voids shall be patched with a suitable material. The patch shall match the finish and texture of the surrounding surface.
3. Patching shall not be allowed on defective areas if the structural integrity of the building is affected.

#### E. Curing and Hardening Concrete

1. Concrete surfaces shall not be allowed to dry out from exposure to hot, dry weather during initial curing period.

#### F. Structural Joints

1. Wall components shall be joined together with two (2) welded plate pairs at each joint.
  - a) Each weld plate shall be 6" long and located one (1) pair in the top quarter and one (1) pair in the bottom quarter of the seam.
  - b) Weld plates shall be anchored into the concrete panel and welded together with a continuous weld.
  - c) Inside seams shall be a paintable caulk.
  - d) Outside seams shall use a caulk in a coordinating building color or clear.
2. Walls and roof shall be joined with weld plates, 3" x 6" at each building corner.
3. The joint between the floor slab and walls shall be joined with a grout mixture on the inside, a matching colored caulk on the outside and two (2) weld plates 6" long per wall.

#### G. Painting/Staining

1. An appropriate curing time shall be allowed before paint shall be applied to concrete. Some applications may require acid etching. A 30% solution of hydrochloric acid shall be used, flushed with water, and allowed to thoroughly air dry.
2. Painting shall not be done outside in cold, frosty, or damp weather.
3. Painting shall not be done outside in winter unless the temperature is 50°F or higher.
4. Painting shall not be done in dusty areas.

### 3.2 Testing

- A. Testing shall only be performed by qualified individuals who have been certified ACI Technician Grade 1.
- B. Sampling shall be in accordance with ASTM C172.
- C. The following tests shall be performed on concrete used in the manufacture of vault toilets. All testing shall be performed in a PCI certified laboratory.
  1. Air content – checked per ASTM C231. The air content shall be in the range of 5.0% +/- 1.5%.
  2. Compressive strength– tested to ASTM C39.
    - a) Two cylinders at release (minimum strength of 2500 psi).
    - b) One cylinder at seven (7) days (minimum strength of 4500 psi).
    - c) Two cylinders at 28 days (minimum strength of 5000 psi).
- D. A copy of all test reports shall be available to the OWNER as soon as 28-day test results are available.

### 3.3 Installation

- A. Excavation and Elevation
  1. Excavation shall be performed in accordance with Section 31 00 00 Earthwork.
  2. Finish floor elevation shall be 4-6" above natural grade measured at the front (entrance) of the exterior slab unless otherwise approved by the OWNER. The back of the building should be slightly higher to allow water to freely drain out of the vault toilet rooms.
- B. Backfill and Compaction
  1. Backfill and compaction shall be performed in accordance with Section 31 00 00 Earthwork.

- END OF SECTION -

## **SECTION 22 05 00 - PLUMBING, GENERAL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide plumbing piping and specialties, complete and operable, as indicated in accordance with the Contract Documents.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. Shop Drawings
  - 1. General arrangement drawings of system components
  - 2. Catalog cuts and other manufacturer information for products
- C. Samples: electrically fused test joint for drainage and vent piping

#### **1.3 WORKMANSHIP AND MATERIALS**

- A. WORK shall in strict accordance with the Uniform Plumbing Code and codes of the State of California, Siskiyou County, and any other authorities having jurisdiction.
- B. The CONTRACTOR shall have required certifications and shall be thoroughly familiar with the local codes.
- C. The CONTRACTOR shall obtain and pay for necessary permits.
- D. Protection
  - 1. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and installation of piping and equipment.
  - 2. The CONTRACTOR shall remove stains and repair damage before final acceptance of the WORK.
- E. Identifying Marks
  - 1. If the ENGINEER finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the CONTRACTOR has furnished proof that said items conform to the Specifications.
  - 2. Adequacy and extent of such proof will be determined by the ENGINEER.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.
- B. Floor drains or floor sinks shall be provided for equipment drains.
- C. No equipment drains shall discharge to floor slabs.

### **2.2 PIPE, FLASHING, DRAINS AND ACCESSORIES**

- A. **Plumbing Pipe.** All plumbing piping and fittings shall be in accordance with the Piping Schedule Contract Drawing, and with the respective individual pipe material specifications.
- B. **Flashing**
  - 1. Vent piping passing through the roof shall be flashed.
  - 2. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in each direction.
  - 3. Flashing shall be fabricated from one piece of spun, heavy, 0.064 prime aluminum or 4-pound lead sheet.

### **2.3 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK**

- A. General
  - 1. For utility piping located inside the building, the CONTRACTOR shall provide hangers and supports for vertical, axial, and seismic loads in accordance with the applicable plumbing code.
  - 2. No perforated strap hangers nor wire supports will be permitted.
  - 3. Pipe supports shall be as indicated in Section 40 23 02 – Pipe Supports.
- B. Spacing
  - 1. Pipe support spacing for plumbing pipe shall be as indicated in Section 40 23 02 – Pipe Supports.
  - 2. Copper tube or pipe support spacing shall be not more than 6 feet between supports.
- C. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.
- D. Vertical piping shall be supported at the base with fittings made for this purpose or shall be supported from the nearest horizontal member or floor with a riser extension pipe clamp.
- E. Inserts

1. Anchors that are installed into existing concrete shall be **Grinnel Figure 117, Modern Figure 740**, or equal, expansion case inserts.
2. Drill clean holes for the insertion of case and patch concrete around the hole, as required.
3. Continuous-slotted concrete inserts, if used, shall be **Crawford Figure 148, Fee & Mason Figure 9000**, or equal.
4. The CONTRACTOR shall provide secondary angle supports between main inserts to handle the loads which can be properly supported by such arrangement.
5. Concrete inserts shall be as indicated in Section 40 23 02 – Pipe Supports.
6. Inserts shall be galvanized.

## 2.4 PIPE SLEEVES

- A. Sleeves shall be constructed from Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.
- B. At exposed wall or ceiling surfaces, install a suitable chromium plated brass wall plate approved by the ENGINEER.

## 2.5 VALVES

- A. **General.** Ball valves, check valves, globe valves, or angle valves required of the plumbing system design shall be in accordance with the requirements of their respective Specification Section.
  1. Valves shall open by turning counterclockwise and shall be provided with suitable handwheels or nuts as required.
- B. **Hose Bibb Valves**
  1. Interior hose valves shall be provided as indicated.
  2. The hose nipple shall be a female iron pipe thread inlet with hose thread outlet.
  3. Hose bibbs shall be the size shown on the Drawings.
- C. **Isolation Shut-Off, Ball Valves**
  1. Water shutoff valves shall be ball type, except on fixture supply piping where globe style isolation valves shall be used.
  2. Provide isolation shut-off ball valves (NPT ends) on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system



3. Shut-off valves shall be placed on hot and cold-water connections to equipment and fixtures.
4. Extra-long barrel stops shall be used where supply piping is concealed behind partitions.
5. Show proposed locations of shut-off valves on the Shop Drawings.

## 2.6 FLOOR DRAINS IN CONCRETE FLOORS

- A. Floor drains in concrete floors shall be constructed of cast iron, in the sizes indicated, and provided with sediment buckets.
- B. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing 12 inches minimum all around.
- C. Where lead flashing does not comply with the Code, use epoxy waterproofing material and submit a Shop Drawing for review.
- D. Manufacturers, or Equal
  1. **Josam Mfg. Co., Series 31120**
  2. **Jay R. Smith Mfg. Co., Fig. 2350**
  3. **Zurn Industries, Inc., Series Z-520-Y**

## 2.7 CLEANOUTS

- A. Cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs.
- B. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.
- C. **Manufacturers**, or Equal

Service	Josam Series	J.R. Smith No.	Zurn No.
Exposed Locations	<b>58500-20</b>	<b>4405</b>	<b>Z-1440-A</b>
Underground (finished floors)	<b>56010/30</b>	<b>4143</b>	<b>ZN-1400-2</b>
Walls, Concealed	<b>58790-20</b>	<b>4535</b>	<b>ZN-1445-1-A</b>
Traffic Areas	<b>56070</b>	<b>4240</b>	<b>Z-1420-27</b>

- D. Cleanouts shall have a minimum diameter of 3 inches.
- E. Stack cleanouts shall be installed at the base of each stack.

- F. Cleanouts shall be fabricated from galvanized cast iron with ABS plastic cleanout plugs.

## 2.8 HOSE BIBBS AND HYDRANTS

- A. Hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type.<sup>7</sup>
- B. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless steel warning signs reading "DO NOT DRINK" in clearly legible letters, permanently attached at the hose bibb.
- C. Hose bibbs shall be provided with vacuum breakers as furnished by **Crane Co., American Standard**, or equal.

## 2.9 WALL-MOUNTED HOSE RACKS

- A. The CONTRACTOR shall provide wall-mounted hose racks at the indicated locations.
- B. Racks shall be of welded steel construction, minimum 8-gauge sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of the indicated hose.
- C. Racks located in the open shall be supported from two 2-by-2-by-1/4-inch galvanized steel angle posts set in a concrete base or as indicated.
- D.

## 2.10 COATING OF PLUMBING MATERIALS

- A. Ferrous metal piping and surfaces, except finished, galvanized, and machined surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 96 00 – Protective Coatings.
- B. Prime colors shall be compatible with finish coats that are applied in the field.
- C. Self-contained units such as wall-mounted hose racks shall be supplied with factory-applied finish coats of baked enamel.
- D. Field painting shall comply with the requirements of Section 09 96 00.

# PART 3 -- EXECUTION

## 3.1 PREPARATION

- A. The CONTRACTOR shall coordinate the roughing-in process with provisions for wall and floor sleeves, pipe inserts, and cutting of roof and floor penetrations, such that drain lines will have the required invert elevations and slopes.

## 3.2 OPENINGS

- A. New Construction

1. The CONTRACTOR shall provide necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the building.
2. Openings shall be as indicated or as required to provide passage for the plumbing WORK.

B. Existing Construction

1. The CONTRACTOR shall provide openings required in existing walls, floors, and roofs for the passage of piping and plumbing equipment.
2. Openings shall be as indicated or required for passage.
3. Openings shall be cut in a neat and orderly manner, minimizing damage to existing structures.
4. Patching of openings shall match existing construction.
5. The CONTRACTOR shall be responsible for hangers and supporting members installed in existing masonry or structural steel as required for the proper completion of the WORK.

### 3.3 INSTALLATION AND APPLICATION

- A. The CONTRACTOR shall provide plumbing specialties in accordance with manufacturer's printed instructions.
- B. Pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.
- C. Pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.
- D. Piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.
- E. Joints
1. Screwed joints shall be made with joint compound and be tight and leak proof.
  2. Sufficient brass-to-ferrous metal seat unions shall be placed in lines such that any pipe, valve, or piece of equipment may be easily disconnected.
- F. Drainage Lines
1. Drainage lines shall be properly run, trapped, and vented to conform to Code requirements.
  2. Changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe.

- 3. Changes in pipe size shall be made with reducing fittings.
  - 4. The minimum depth of cover shall be 3 feet.
  - G. Horizontal soil, drain, and waste pipes shall be provided with a slope of at least 1/4 inch per foot, unless indicated otherwise.
  - H. Floor drains and cleanouts shall be installed such that the tops of the drains are flush with the finished floor.
  - I. Joints in PE pipe shall be installed such that the longitudinal pull out resistance of each joint is at least equal to the tensile strength of the pipe
- 3.4 EQUIPMENT DAMAGE AND REMOVAL
- A. The CONTRACTOR's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment that are to remain in the finished WORK.
  - B. Any damage caused by the CONTRACTOR or Subcontractor through their operations shall be repaired to the satisfaction of the ENGINEER.
- 3.5 TESTING
- A. The CONTRACTOR shall perform such tests as are required by local ordinances and Codes in the presence of a local governing authority inspector to show that piping is tight, leak-free, and otherwise satisfactory, and shall also perform such tests as the ENGINEER may direct to ensure that fixtures and equipment operate properly.
  - B. The CONTRACTOR shall pay the costs to perform such tests and the costs of making changes or repairs until the WORK is acceptable to the governing authorities.

- END OF SECTION -

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## **SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. This Section includes the following:**

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.

**B. Mechanical systems shall include the following items to the extent required on plans or in other sections of these specifications.**

1. All piping systems inside the building.
2. All piping systems exterior to the building.
3. All equipment associated with the above systems.

#### **1.2 PERFORMANCE REQUIREMENTS**

**A. Seismic-Restraint Loading:**

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.
  - a. Component Importance Factor: **1.0**.
  - b. Component Response Modification Factor: **2.5**.
  - c. Component Amplification Factor: **See ASCE 7-16 Table 13.6-1**

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): **0.519g**

4. Design Spectral Response Acceleration at 1-Second Period: **0.405g**

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Product Data:** For each product indicated.
- C. **Delegated-Design Submittal:** For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. The isolator manufacturer shall furnish submittals indicating capacities and sizes of isolators and bases for isolated equipment. Data shall include outside diameter and heights (free, operating, solid) of springs; free and operating heights of neoprene and fiberglass isolators; and loads on each isolator. Calculations and selection data shall include structural consideration, such as floor span, slab on grade, etc.
- E. All calculations and selection shall be based on the actual equipment to be installed whether the equipment is as specified or is a substitute item.
- F. Provide a schedule of equipment being supported listing the specific isolation device proposed for approval. Include the approved schedule with the Operation and Maintenance Manual.
- G. Welding certificates.
- H. **Qualification Data:** For professional engineer.
- I. Field quality-control test reports.

### 1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC and ASCE 7-16 unless requirements in this Section are more stringent.
- B. **Welding:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

- D. The Contractor shall coordinate with the supplier of vibration isolation equipment to ensure isolators are sized for the actual equipment supplied.
- E. The supplier of equipment specified in this Section shall coordinate with all trades to identify the locations of all required isolation devices.

## **PART 2 - PRODUCTS**

### **2.1 VIBRATION ISOLATION PRODUCTS**

- A. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1. Kindorf.
- 2. Grinnell.
- 3. Elcen.
- 4. Unistrut.
- 5. Kinetics Noise Control.
- 6. Mason Industries.
- 7. Vibration Eliminator Co., Inc.
- 8. Amber Booth

- B. **SUPPORTS**

- 1. Equipment isolator pads shall be Mason type W neoprene waffle pad. Provide an appropriate durometer or equal (hardness) for a recommended loading of 40 to 60 psi. Provide pad with steel backing plate or other options as required for the application.
- 2. Neoprene isolators shall be Mason model ND or equal and shall incorporate completely enclosed metal inserts to permit bolting to the supported unit.
- 3. Spring isolators shall be Mason model SLF or equal. Units to be freestanding, unhoused, laterally stable spring mounts, incorporating leveling bolts and 1/4" thick noise isolation pads. The outside spring diameter shall be equal to or greater than 80% of the designed spring operating height, and the horizontal stiffness shall be at least 80% of the vertical stiffness. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

- C. **HANGERS**

- 1. Equipment hanger isolators shall be combination series elastomer spring type, Mason Industries model 30N or equal. Elastomer element shall provide an isolation bushing for the hanger rod. Units shall have stamped or welded housings with a lower hole



large enough to allow 30° movement of the lower rod before contacting the housing. Springs shall be laterally stable and shall have a minimum additional travel to solid equal to 50% of the rated deflection. Elastomer element shall be rated for a minimum of .25" deflection.

2. Hanger isolators for equipment under 75 lbs. shall be Mason Model HD or equal.
3. Isolated ceiling hangers shall include welded steel assemblies designed to be incorporated into the isolated ceiling suspension system specified for this project. Hanger assembly brackets shall be designed to allow a 15 degree off vertical alignment of ht suspension member without making metal-to-metal contact between suspension and hanger assembly members. Isolation hanger load capacities shall be selected by the manufacturer to provide a minimum vertical static deflection of the steel spring element of 1.0 inch and maintain an additional deflection to solid of 0.5 inch. Hanger assemblies shall include a method by which the installing contractor can preload the steel spring element to restrict additional vertical deflection of the steel spring to 1/4" on installation of finish ceiling materials.

## 2.2 SEISMIC PRODUCTS

### A. CABLE SUPPORT ASSEMBLIES

1. Cables and Cable End Connections:
  - a. Manufacturers
    - 1) Kindorf.
    - 2) Grinnell.
    - 3) Elcen.
    - 4) Unistrut.
    - 5) Kinetics Noise Control.
    - 6) Mason Industries.
    - 7) Vibration Eliminator Co., Inc.
    - 8) Amber Booth
  - b. Steel cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide an all directional restraint.
  - c. Cable end connections shall be steel assemblies that swivel to final installation angle. Cable end connections shall utilize two clamping bolts to provide proper angle engagements.
2. Rod Clamps:
  - a. Manufacturers

- 1) Kindorf.
- 2) Grinnell.
- 3) Elcen.
- 4) Unistrut.
- 5) Kinetics Noise Control.
- 6) Mason Industries.
- 7) Vibration Eliminator Co., Inc.
- 8) Amber Booth

b. Clamps designed to secure steel angles to rods.

#### B. PIPE SUPPORT ASSEMBLIES

1. Manufacturer:
  - a. B-Line
2. Pre-engineering piping seismic restraint system designed to resist seismic loading in any direction.
3. Certified and signed by registered professional structural engineer that details are in accordance with the requirements of the International Building Code for the listed seismic criteria.
4. System shall be a complete seismic system and shall include:
  - a. Installation details and devices for vertical, transverse and longitudinal bracing.
  - b. Attachment details to structure complete with bolt types and sizes.

### PART 3 - EXECUTION

#### 3.1 APPLICATIONS

- A. **Multiple Pipe Supports:** Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

#### 3.2 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

### 3.3 SEISMIC PROVISION SPECIFIC

#### 1. General:

- a. All in-line equipment shall be braced independently of pipe or ducts.
- b. Welding shall conform to AWS D1.1 and shall use either shielded or submerged arc methods.
- c. When conduit is to be installed, it shall be braced the same as the equivalent weight pipe.
- d. Use either cable or solid bracing for all situations. Do not mix bracing types in the same direction.
- e. Bolt holes shall be 1/8 inch larger than the bolt diameter unless otherwise noted.

#### 2. Piping System

- a. Support and brace piping as specified herein.
  - 1) At the Contractor's option, a pre-engineered support system specified in this section may be utilized. Support and brace piping system in complete accordance with the manufacturer's recommendations.
- b. Brace all pipes 2-1/2 inch and larger.
  - 1) Exceptions:
    - a) Brace all fuel oil, gas piping (including fuel gases, medical gases and compressed air) 1-inch ID and larger.
    - b) Brace all piping in boiler and mechanical equipment rooms 1-1/4" ID and larger.
    - c) Bracing is not required for piping suspended from individual hangers 12 inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached and where the hanger provides a non-moment generating (swivel) connection to the structure.
- c. Details indicated provide lateral bracing system. A typical vertical support system must also be used. However, where brace occurs, the vertical angle shown may replace a typical vertical support.
- d. Transverse bracings at 40 feet on center maximum.
  - 1) Except gas piping shall be at 20 feet.
  - 2) Except where lesser spacing is indicated in the tables.

- e. Longitudinal bracings at 80 feet on center maximum.
  - 1) Except gas piping shall be at forty feet.
  - 2) Except where lesser spacing is indicated in the tables.
- f. Transverse bracing from one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches (610 mm) of the elbow or tee and similar size.
- g. Do not use branch lines to brace main lines.
- h. Provide oversized pipe sleeves through walls or floors to allow for anticipated differential movements.
- i. Provide flexibility in joints where pipes pass through building seismic or expansion joints, or where rigidly supported pipes connect to equipment with vibration isolators.
  - 1) For threaded piping, the flexibility may be provided by the installation of swing joints.
  - 2) For piping with manufactured ball joints, select the length of piping offset using Seismic Drift in place of the expansion given in the joint manufacturer's selection table. Seismic Drift = 0.015 feet per foot of height above the base where seismic separation occurs.
- j. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 30 feet (9.1 m) on center.
- k. Do not fasten one rigid piping system to two dissimilar parts of a building that may respond in a different mode during an earthquake; for example, a wall and a roof.
- l. Piping grouped for support on trapeze-type hangers shall be brazed at the same intervals as determined by the smallest diameter pipe of the group. Hanger rods shall be increased in cross-sectional area proportionate to the increased weight per linear foot of pipe and contents supported at each trapeze hanger. No trapeze-type hanger shall be secured with less than two ½ inch (12.7 mm) bolts.
- m. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.
- n. Spreaders shall be provided between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches (102 mm) or four times the maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing

high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.

o. Flexible Couplings or Joints:

- 1) Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers 3-1/2 inches size and larger. Cast-iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets or no-hub fittings may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to comply with these requirements.
- 2) All underground piping except heat distribution system, shall have flexible couplings installed adjacent to building as shown. Additional flexible couplings shall be provided as follows:
  - a) On each side of the joints of demarcation between soils having widely differing degrees of consolidation.
  - b) At all points that can be considered to act as anchors.
  - c) On every branch of a tee and each side of an elbow.

- END OF SECTION -

## **SECTION 23 05 00 - HEATING, VENTILATION, AND AIR CONDITIONING, GENERAL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide heating, ventilating, and air conditioning systems and associated equipment complete with supports, mounting frames, ventilators, ductwork, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, appurtenances, testing, and balancing, as indicated in accordance with the Contract Documents.
- B. Where a conflict exists between the specifications and or the contract drawings the more stringent of the requirements will apply.
- C. The equipment shall be installed ready for operation.

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

- A. Codes, as referenced herein, are indicated in Section 01 42 10 – Reference Standards.
- B. The WORK and materials shall be in full accordance with the latest rules and regulations or publications of the state of California, the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local plumbing code, the local building code, and other local codes.
- C. Nothing in the Contract Documents shall be construed to permit WORK in violation of the above codes, rules and regulations.
- D. In the absence of applicable codes, the installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Equipment submittals
  - 1. At a minimum, the contractor shall provide the ENGINEER a complete submittal package for each piece of equipment, accessory, and controller listed in the mechanical schedule. A complete submittal package will also be provided to the ENGINEER for all supports and hangers that will be used on the project. Reference individual spec sections for specific submittal requirements. All submittals shall be in accordance with the requirements in Section 01 33 00 – Contractor Submittals.
- B. Shop Drawings
  - 1. Submit complete shop drawings and certificates, test reports, affidavits of compliance, for all equipment, ductwork and piping systems, in accordance with the requirements

in Section 01 33 00 – Contractor Submittals, and as indicated in the individual equipment, piping or ductwork Sections.

2. Construction Drawings

- a. The HVAC Drawings define the general layout, configuration, routing, size and the general intent of the design and are not fabrication drawings.
  - b. It shall be the CONTRACTOR's responsibility to develop the Shop Drawings required for the construction of the HVAC system.
3. The Shop Drawings shall include all necessary dimensions and details regarding equipment, pipe and ductwork joints, fittings, valves, appurtenances, design calculations, and material lists.
  4. The submittals shall include detailed layout, spool, or fabrication drawings which shall show all fittings, and supports as necessary to accommodate the equipment as a complete and functional system.

C. Equipment Numbers

1. Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents.
2. Indicate the appropriate equipment numbers on the Shop Drawings and other submittals.

D. Furnish certified fan curves for each fan.

E. Acoustic Louver Certification: The manufacturer shall submit certified data from a laboratory, substantiating the specified performance of the acoustic louvers.

F. Close Out Documents: Operations and Maintenance information will be provided for all equipment and accessories in accordance with the requirements of specification 01 77 00 Project Closeout.

1.4 WARRANTY

- A. Air conditioners, heaters, fans, ventilators, grilles, and the like, that are provided by the CONTRACTOR shall carry the manufacturer's standard warranty.
- B. Warranties shall be furnished to the ENGINEER upon final acceptance of the completed systems by the OWNER.
- C. Refrigerant compressors shall carry a manufacturer's 5-year warranty.
- D. Control System
  1. The temperature and equipment control system shall be warranted free from defects in workmanship and material under normal use and service for a period of one year after acceptance by the ENGINEER.

2. Equipment that proves to be defective in workmanship or material during the warranty period shall be adjusted, repaired, or replaced by the automatic control manufacturer as part of the Contract.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

#### **A. Quality**

1. Mechanisms and other parts shall be amply proportioned for the stresses which may occur during operation and for any other stresses which may occur during fabrication and erection.
2. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials, and shall be of the manufacturer's top-line, industrial-commercial grade.

#### **B. Supports**

1. Equipment and appurtenances shall be firmly anchored or connected to supporting members.
2. Equipment shall be supported on restrained spring-type vibration isolators.
3. Supports as required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided unless otherwise indicated.

#### **C. Noise and Vibration Control**

1. The system shall be free of objectionable vibrations and noise.
2. Provide flexible connections in ducts and piping connections to fans, compressors, and other vibrating equipment.

### **2.2 MOTORS**

- A. Motors provided with the equipment shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.
- B. Motors shall be in conformance with the requirements of Section 26 05 10 Low-Voltage AC Electric Motors.
- C. Each motor shall bear the manufacturer's nameplate with complete motor data.
- D. Each motor shall be of ample size and construction to continuously carry the loads which might be imposed by the equipment throughout the full range of operation of the equipment.
- E. The maximum motor loading shall be less than or equal to the nameplate horsepower rating, exclusive of the service factor.



## 2.3 ELECTRICAL WORK

### A. General

1. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, motorized dampers, louver operators and other equipment as indicated.
  2. Provide control wiring of 120-volt and less as indicated in this Section and in conformance the requirements of Section – 26 05 83 Wire & Cable. Provide local power disconnects, where required.
  3. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.
- B. Starters, whether as an integral or separate part of the equipment, shall be in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.
- C. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.
- D. Starters shall be of the same manufacturer as the starters indicated under Section 26 05 10 – Low-Voltage AC Electric Motors.
- E. Low-voltage control wiring shall be in accordance with the National Electric Code.
- F. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Section 26 05 83 – Wires and Cables.
- G. Control Panels shall be in conformance with the requirements of Division 26 – Electrical.
- H. Conduit shall be in conformance with the requirements of Section 26 05 33 – Electrical Raceway Systems and Section 26 05 43 – Underground Raceway Systems.

## 2.4 FLASHING

- A. Equipment that passes through roofs of buildings or structures shall be provided with flashing as indicated.
- B. Flashing shall be in conformance with the requirements of Section 07 62 00 – Sheet Metal Flashing and Trim.

## 2.5 PIPE AND FITTINGS

- A. Refrigerant piping shall be Type L hard temper copper with cast brass fittings.
- B. Provide a drain at each low point in the piping system.
- C. Copper fittings shall be in conformance with the requirements of Section 23 23 00 – Refrigeration Piping.

- D. Joints in refrigeration piping shall be made with silver solder.

## 2.6 PIPING AND DUCTWORK INSULATION

- A. Heating piping, refrigerant piping, and supply and outside air ductwork shall be insulated as indicated and as required per state and local codes.
- B. Insulation shall be in conformance with the requirements of Section 23 07 00 – HVAC Insulation.

## 2.7 WELDING

- A. The welding of black steel or alloy pipe shall be carried out in strict accordance with AWS procedures and the codes and ordinance of the State of California and local codes pertaining to welded steel pipelines.
- B. Welding shall be accomplished by means of the shielded electric arc process and performed by workers who are certified for this WORK.

## 2.8 HANGERS AND SUPPORTS

- A. Provide all necessary hangers, supports, concrete inserts, anchors and guides for material and equipment to be installed.
- B. No perforated strap hangers and no wire supports will be accepted.
- C. Insulation Allowance
  - 1. Hangers supporting insulated pipe shall be sized to fit the pipe plus the insulation.
  - 2. The insulation at support points shall be provided with a metal shield in order to prevent damage to the insulation.
- D. Anchors and guides shall be constructed of steel, in accordance with approved Shop Drawings, and as indicated.
- E. Pipe hangers used to support uninsulated copper piping shall be copper-plated.
- F. Anchors
  - 1. Anchorages shall be obtained by welding lugs onto the pipe and providing abutting surfaces against the lugs to restrict longitudinal movement.
  - 2. Anchors shall be designed such that the pipe may be removed by removing bolts; no welding of pipe to the anchor will be accepted.
  - 3. bolting materials shall be cadmium-plated.
- G. Guides shall be located not more than 20 feet from each expansion loop or joint.

- H. Horizontal runs of pipe shall be provided with supports spaced such that the sag of the unsupported length will not create any pockets in the piping (weight of fluid included).
- I. Pipe support lengths shall be in conformance with the requirements of Section 40 23 02 – Pipe Supports.
- J. Vertical Piping
  - 1. Vertical piping shall be:
    - a. supported at the base with fittings made for this purpose; or
    - b. supported from the nearest horizontal member or floor with a riser extension pipe clamp.
  - 2. Provide a riser extension clamp at each floor.
- K. Hangers for ductwork and equipment shall be as indicated and in accordance with the guidelines of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- L. Inserts shall be galvanized.

## 2.9 PIPE SLEEVES

- A. The CONTRACTOR shall examine the Drawings carefully for sleeves that are to be built into the construction and plan the WORK accordingly, such that the sleeves are placed well in advance and care is taken with their location and support until encased.
- B. Sleeves shall be fabricated from standard weight galvanized steel pipe for dry interior installations.
- C. Sleeves for exterior or wet installations shall be fabricated from standard-weight ductile black steel, stainless steel, or standard-weight PVC for pipe temperatures below 120 degrees F.
- D. Sleeves shall be sized one pipe size larger than uninsulated piping and one pipe size larger than piping plus insulation for insulated pipe.
- E. Locations
  - 1. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor.
  - 2. Where pipes pass through walls, sleeves shall be flush with the wall.

## 2.10 MOTORIZED DAMPERS

- A. General
  - 1. Provide the motorized opposed blade dampers as indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The damper and frames shall be fabricated from aluminum with a minimum thickness of B&S 12-gauge.
2. The aluminum blades shall be provided with interlocking edges, with one center and two edge crimps, and brass bearings.
3. The frame shall be of welded channel construction, and shall be provided with lugs and mounting brackets for damper operators.
4. The dampers shall be provided with felt or rubber seals at their edges in order to minimize air infiltration when closed.

C. Motors

1. Damper motors shall be 120V electric type; with necessary linkages for positioning the damper blades.
2. The motors shall be powered open and spring-closed, unless otherwise indicated.

## 2.11 BACKDRAFT OR GRAVITY DAMPERS

A. General

1. Provide backdraft dampers on the exhaust fans and ventilators where indicated.
2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The dampers shall be of the multi-blade type, with soft-seating gaskets for minimizing noise and air leakage when closed.
2. Blades shall be constructed of 16-gauge aluminum, and shall be of an air foil design.
3. Frames shall be fabricated from 16-gauge extruded aluminum alloy.
4. The frames shall be totally out of the air stream, and arranged for flange mounting.
5. The dampers shall be designed to operate at 0.05 inch w.g. S.P., or less.
6. Blades shall be individually counterbalanced, and shall be provided with non-ferrous pins turning in nylon bearings.

C. Damper Manufacturers, or Equal

1. **Air Balance, Inc.**

## **2. Air Dynamic**

## **3. Ruskin**

### **2.12 VOLUME CONTROL DAMPERS (MANUAL AND MOTORIZED)**

#### **A. General**

1. Provide volume control dampers in accessible locations in branch supply ducts and at each exhaust air opening, in order to properly regulate the volume of air delivered or withdrawn from each inlet and outlet, and as indicated.
2. Damper sizes and capacities shall be as indicated on the Drawings.

#### **B. Construction**

1. The volume dampers shall be of the opposed blade type.
2. The dampers shall be constructed of aluminum, of B & S 14-gauge thickness.
3. The dampers shall be suitably reinforced with sturdy control shafts.
4. Ductwork shall be reinforced to double thickness at damper shaft openings.

#### **C. Air Extractor Type**

1. The volume control dampers indicated to be of the air extractor type shall be constructed of stainless steel, of 20-gauge for frames and of 24-gauge thickness for blades.

#### **D. No splitter dampers will be accepted.**

#### **E. Manual control dampers shall be provided with mechanisms for adjustment and locking into position after being set.**

#### **F. Motors**

1. Damper motors shall be electric type; with either modulating or 2-position control and necessary linkages.
2. The motors shall be powered open and spring-closed, unless otherwise indicated.

### **2.13 FIRE DAMPERS**

#### **A. General**

1. Provide fire dampers in ductwork at floor penetrations and at fire-rated wall penetrations, whether or not indicated.
2. Fire dampers shall be in accordance with the codes of the State of California and the provisions of NFPA Bulletin 90A.

3. Fire dampers shall be of the fusible link type and shall be UL-approved.
- B. The units shall be arranged for horizontal or vertical mounting, and shall be provided with a 165-degree F fusible link.
- C. Provide an end switch on the fire dampers to signal the fire alarm and de-energize fan motors in the event of a fire.
- D. Fire dampers shall be 1-1/2-hour **Ruskin FD35**, or equal.

## 2.14 REGISTERS, GRILLES AND DIFFUSERS

### A. General

1. Provide supply and return registers and grilles, and all supply diffusers as indicated.
  2. The sizes, capacities, and deflection of each unit shall be as indicated on the Drawings.
- B. The finish shall be selected by the architect from the manufacturers standard color selection and will be a baked-on enamel type finish.
- C. Accessory equipment shall be constructed of aluminum, or steel if aluminum is not available, and provided with a baked-on enamel finish with the finish color selected by the architect from the manufacturers standard color selection.
- D. The proper border style shall be selected by the CONTRATOR to suit the installation conditions.
- E. Registers, grilles, and diffusers located in corrosive atmospheres, as indicated, shall be painted with a special protective coating in accordance with the requirements of Section 09 96 00 – Protective Coatings.

## 2.15 FLAT AIR FILTERS

- A. **General.** Flat air filters used in the fresh air intakes, packaged air conditioning units, and electric heat pumps shall be 2-inch thick, pleated, throw-away type, and provided as an integral part of each unit and filter box.
- B. **Filter Spares and Supplies**
1. Furnish 3 complete spare filter changes for each flat filter in each unit and filter box.
  2. Provide one new filter set in each unit and filter box at the time of turning the units over to the OWNER.
  3. Filters used in the units and filter boxes during construction are not included in the above supply, and these filters shall be provided as part of the WORK.
- C. **Construction.** The air filters shall be:

1. constructed of an adhesive-coated fiber media;
2. rated at 300-fpm face velocity; and
3. rated at 0.04-inch w.g. initial resistance and 0.50-inch w.g. recommended final resistance.

**D. Manufacturers, or Equal.**

1. **Airguard Industries**
2. **Farr Co.**
3. **Snyder General Corp.**
4. **Camfil**

**E. Filter Racks**

1. The filter racks using the above filter shall hold a minimum of 1 panel and have hinged access doors with gaskets on both sides.
2. Filter racks shall be manufactured by the Louver manufacturer and provided as part of a complete system with the louver as noted in the mechanical.

**2.16 AIR FILTER GAUGES**

**A. General**

1. Provide air filter gauges on each filter box and filter section for air handling unit packaged air conditioning units.
2. The air filter gauges shall be of the inclined tube manometer type.

**B. Construction**

1. Provide the gauge complete with:
  - a. an enameled scale with a screw-type zero adjustment;
  - b. a rust-resistant steel frame;
  - c. a 3/16-inch plate glass removable cover;
  - d. oil;
  - e. screened inlet and outlet nozzles;
  - f. a level glass;
  - g. an oil chamber; and

- h. necessary connecting piping and accessories.
- 2. Each gauge shall be 10 inches long with a total scale reading of 1.0 inch water and 0.1-inch scale graduations.
- 3. Accuracy shall be within 0.02 lineal inch at any point on the scale.
- 4. Gauges shall be mounted level and provided with necessary pressure sensing tubing.
- 5. Gauges shall not be mounted on fan housing or casings containing rotating or reciprocating machinery.

C. **Manufacturers, or Equal:**

- 1. **F.W. Dwyer Company**
- 2. **Honeywell, Inc.**

2.17 VIBRATION ISOLATORS

A. General

- 1. Provide vibration control isolation all rotating equipment except electric motors.
- 2. Where rotating units are part of factory-assembled package units, such as a package air handling unit, provide the isolator under the unit casing.

B. Mount floor-mounted or platform-mounted built-up or package air handling units on structural steel or concrete bases with isolator springs and brackets.

C. Springs used in the vibration isolators shall have approximately one inch of deflection under load, and shall have a minimum additional travel of 50 percent between the design height and the solid height.

D. All isolation equipment shall be provided in strict compliance with the manufacturer's recommendations.

E. Pads

- 1. For vibration isolation between HVAC equipment and supports and where indicated, provide 3/4-inch-thick rubber pads for full contact between equipment and support
- 2. The pads shall be **Mason Industries, Super W Pads, Kinetics** or equal.

F. **Equipment Supports (Outdoor Condenser Unit)**

- 1. Provide pre-fabricated equipment support frame for ground mounted equipment.
- 2. Equipment stand to be tubular steel support frame, hot-dip Galvanized.
- 3. Minimum height to unit invert of 12" above FG.



4. Secure Equipment Support Frame with post drilled ½" dia. galvanized steel epoxy adhesive anchors. Install per manufacturers recommendations.
5. **Manufacturers, or Equal**
  - a. **Big Foot System Stand Range**

## 2.18 TEMPERATURE AND EQUIPMENT CONTROL

### A. General

1. Design and provide a complete electric-electronic system of automatic temperature control as indicated.
2. The temperature control equipment and devices shall be furnished by **Johnson Controls, Honeywell or approved equal.**

### B. Wiring and Switches

1. Provide wiring incidental to the temperature control system, including electrical interlock.
2. Furnish detailed wiring diagrams along with necessary supervision.
3. Provide control wiring (line voltage or low voltage) as required to complete the temperature control system (by interconnecting starters, thermostats, PE switches, relays, and like devices) in accordance with the requirements of Division 26 – Electrical.
4. Provide HOA switches in accordance with the requirements of Division 26 – Electrical.
5. Switches shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

### C. Thermostats

1. Room thermostats shall be of the digital type, provided with heating and cooling setpoints.
2. Adjustment shall be accomplished by pressing the thermostat UP or DOWN arrows.
3. Comfort Setpoints: adjustable from 40 to 0 degrees F
4. Setback Setpoints: adjustable from 40 to 70 degrees F for heating setback;
5. Automatic Setback Time Period:
  - a. 7-day setback programming;
  - b. up to 2 automatic setback comfort time periods per day;

- c. built-in setback override, adjustable from 10 minutes to 40 hours;
  - d. 7-day electric time clock; and
  - e. heat/cool/fan annunciators to indicate equipment operation and automatic heating/cooling changeover
- 6. The thermostats shall meet the Energy Conservation Standard approval where required by the State having jurisdiction over the Project.
  - 7. Provide an insulating back where exterior wall mounting is indicated.
  - 8. Provide guards for room thermostats installed in areas other than administrative offices or control rooms.

#### D. Relays

- 1. Provide 2-position relays, capacity relays, sequencing relays, and other controls as necessary in order to provide a properly operating automatic control system.
- 2. Relays shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

#### E. Control Panels

- 1. General
  - a. Control panels shall be provided with relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gages, thermostats (unless otherwise indicated), and other accessories necessary for the particular system.
  - b. The panels shall be of aluminum construction with a baked enamel finish, and shall be provided with a hinged front door and locking handle.
  - c. Manual switches and direct-reading gauges shall be flush-mounted on the front face, and identified by engraved and riveted **Bakelite** or laminated plastic nameplates with white letters on black background.
  - d. Manual switches shall be of heavy-duty, oil-tight construction.
- 2. Wiring
  - a. Control devices shall be prewired internally.
  - b. Wires leaving the panel shall be terminated at separate numbered terminal strips.
  - c. Provide individual connectors for every item of mechanical equipment, integral and remote pilot lights, and other devices described for each panel.

- d. Power and control circuit requirements shall be as indicated on the Electrical Drawings.
  - e. Identify wires by color coding or numerical tags at both ends.
  - f. Wire each control device to the terminal strip without splices.
  - g. Provide integral circuit protection for panel-mounted control devices.
  - h. Wire each panel with a single 20-amp, 120-volt, AC feeder in accordance with the requirements of Division 26 - Electrical.
3. Diagrams
- a. Secure the panel electrical wiring diagrams to the inside of the panel door.

## **F. Sequence of Operation**

1. Electric Unit and Downflow Heater controls
- a. Wall mount space/unit heaters are to be tied into (1) thermostat located a minimum of 5'-0" from the personal door for each building or as is practical. The space temperature for each building shall be maintained at a minimum 40 degrees to prevent freezing conditions inside the building envelope.
  - b. The ceiling/roof mounted downflow electric heater will be tied into (1) thermostat that will be set at 5 degrees above the set point of the wall mount space/unit heaters thermostat.
  - c. During Standby Power Mode and startup of the genset unit the Electric heater time delays shall be staggered with each other and the heaters in the other buildings to prevent overload of standby generator on startup. Coordinate all electric heater time delay relay setups with the electrical contractor.
2. Propeller Exhaust Fan Controls
- a. Wall mounted propeller exhaust fans will be controlled by a ON/OFF switch located near the personal door of each building. When the Propeller exhaust fans are switched ON the motorized backdraft damper at each propeller fan is powered open. The intake air louvers that interlocked with each respective propeller fan as noted in the mechanical schedule are powered open.
  - b. When the propeller fans are switched OFF the fans shall power down. Motorized back draft dampers will power closed. The intake air louvers that are interlocked with each propeller fan will closed.
3. Fresh Air intake Fans
- a. Fresh Air intake fans shall be switched ON once the building wall mounted occupancy sensor is triggered. Fan shall remain ON while the building is

occupied. Upon the occupancy sensor timing out due to not sensing any occupants in the building the fresh air intake fan will be switched OFF.

- b. A barometric relief air damper shall allow excess air pressure to be relieved from the building during operation of the fresh air fan.

#### 4. Electric Radiant Heaters

- 1) Electric radiant heater will be switched ON and OFF by an ON/OFF switch located on the wall of the building.

### 2.19 ELECTRIC HEATING CABLE

#### A. **General:**

- 1. self-regulating
- 2. 150 degrees F maintenance temperature
- 3. 120-volt
- 4. 3 watts per ft. output
- 5. twin 16-AWG copper buss wires within insulated jacket

- B. After the pipe has been heat traced, insulate and apply exterior jacketing in accordance with the requirements of Section 23 07 00 – HVAC Insulation.

#### C. **Manufacturers**, or Equal

- 1. **Chromalox**

### 2.20 PAINTING

- A. Painting of the equipment and materials shall comply with the requirements of Section 09 96 00 – Protective Coatings.

#### B. Field Touch-Up Coating Repair

- 1. Touch up factory-coated surfaces that are rusted or scratched.
- 2. Clean finishes to be touched up to bright metal, prime with a corrosion inhibitor, and finish with a coating to match the original finish.

## PART 3 -- EXECUTION

### 3.1 GENERAL

#### A. Openings - New Construction

1. Provide necessary openings in walls, floors and roofs for the passage of heating and ventilating equipment in the buildings.
2. Openings shall be as indicated or as required to provide passage for heating and ventilating WORK.
3. Provide hanger and support inserts into masonry or structural steel as required for proper completion of the WORK.

B. Openings - Existing Construction

1. Provide openings required in the existing construction for piping and equipment that are not specifically indicated.
2. Openings shall be cut in a neat and orderly manner with as little damage to existing structures as possible.
3. The patching of openings that have been cut shall match the existing construction.
4. Provide hangers and supporting members installed in the existing masonry or structural steel as required for proper completion of the WORK.

### 3.2 INSTALLATION OF PIPING

A. Drain Piping

1. Valve-Drain Piping
  - a. Provide valve-drain piping where valves are equipped with a drain connection.
  - b. Fabricate piping from Type L copper tube, and solder-joint drainage fittings.
2. Provide piping system and equipment drains fabricated from copper tube with solder-joint fittings, or from black steel piping with fittings as indicated.
3. Install drain piping at the low points of supply and return piping, at abrupt changes in vertical offsets in horizontal runs, and in piping at mechanical equipment including pumps.
4. Extend drain piping to the nearest drain.

B. Bypass Piping

1. Except as otherwise indicated, fabricate and install bypass piping using the same materials and in the same plane as connected piping, but one pipe size smaller or as indicated.
2. Provide a valve in the bypass piping.

### 3.3 INSTALLATION OF VALVES

1. Set the valves carefully regarding their location with respect to accessibility and the equipment being controlled.
2. Give consideration to the location of valves with respect to the proper drainage of the piping system.
3. Install valves where required for proper operation of piping and equipment, including valves in branch lines necessary to isolate sections of piping.
4. Locate valves to be accessible and such that separate support can be provided where necessary.
5. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward.
6. Where insulation is indicated, install extended-stem valves, arranged in the proper manner to receive insulation.
7. Control Valve Installation
  - a. Coordinate valve submittals for type, quantity, size, and piping configuration, in order to ensure compatibility with pipe design.
  - b. Slip-stem control valves shall be installed such that the stem position is not more than 60 degrees from the vertical up position.
  - c. Install ball-type control valves with the stem in the horizontal position.
  - d. Install valves in accordance with the manufacturer's recommendations.
  - e. Install valves such that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes or equipment.
  - f. Install isolation valves such that the control valve body may be serviced without draining the supply- or return-side piping system.
  - g. Install unions at connections to screw-type control valves.
  - h. Identification Tags
    - 1) Provide tags for control valves, indicating service and number.
    - 2) Tags shall be brass, 1.5 inch in diameter, and with 1/4-inch high letters.
    - 3) Securely fasten tags with chain and hook.
    - 4) Match identification numbers as shown on approved control Shop Drawings.

### 3.4 BALANCING AND TESTING

#### A. Balancing Subcontractor

1. After the installation WORK has been completed, the CONTRACTOR shall provide the services of an independent balancing subcontractor who shall perform necessary adjustments of volume dampers, volume controllers, exhaust blowers, exhaust fans, supply blowers, supply and return registers, and heating units. All work shall be in accordance with the requirements of Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC.
2. The balancing subcontractor shall balance the hot water heating system, provide all pressure gauge tapings, and through the use of balancing valves adjust water flows.
3. The balancing subcontractor shall:
  - a. have at least 5 years of balancing experience, and experience in at least 5 projects of the Project type;
  - b. not be associated with any firms doing engineering or construction work in HVAC and/or Plumbing;
  - c. use the balancing methods approved by the Associated Air Balance Council; and,
  - d. send a copy of all correspondence and reports, as they are written, pertaining to this project, directly to the ENGINEER.

#### B. The CONTRACTOR shall:

1. provide labor, tools, testing equipment and appliances for the necessary testing and adjustment that is required;
2. submit to the ENGINEER an experience resume and project resume for approval of the balancing subcontractor;
3. demonstrate to the OWNER, in an extensive operating test covering every component of the installation, that the entire heating, ventilating and air conditioning system meets the indicated requirements and is ready for continuous, satisfactory operation; and,
4. make repairs and revisions as necessary to make the system operative, as part of the Contract.

### 3.5 VIBRATION ISOLATORS

- #### A. Install isolation equipment in strict compliance with the manufacturer's recommendations.

### 3.6 TEMPERATURE AND EQUIPMENT CONTROL

- A. After completion of the installation, use trained personnel to adjust thermostats and sensors in the motors and other provided equipment, and place them in complete operating condition subject to the approval of the ENGINEER.
- B. Instruct the operating personnel in the operation of the control system.

- END OF SECTION -



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## SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals

#### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

#### 2.2 MOTOR CHARACTERISTICS

- A. **Duty:** Continuous duty at ambient temperature of 40 deg C and at altitude of 2,000 feet above sea level.
- B. **Capacity and Torque Characteristics:** Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

#### 2.3 POLYPHASE MOTORS

- A. **Description:** NEMA MG 1, Design B, medium induction motor.

- B. **Efficiency:** Energy efficient, as defined in NEMA MG 1.
- C. **Service Factor:** 1.15.
- D. **Multispeed Motors:** Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. **Rotor:** Random-wound, squirrel cage.
- F. **Bearings:** Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. **Temperature Rise:** Match insulation rating.
- H. **Insulation:** Class F.
- I. **Code Letter Designation:**
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. **Enclosure Material:** Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. **Motors Used with Reduced-Voltage and Multispeed Controllers:** Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. **Motors Used with Variable Frequency Controllers:**
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

## 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
  2. Split phase.
  3. Capacitor start, inductor run.
  4. Capacitor start, capacitor run.
- B. **Multispeed Motors:** Variable-torque, permanent-split-capacitor type.
- C. **Bearings:** Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. **Motors 1/20 HP and Smaller:** Shaded-pole type.
- E. **Thermal Protection:** Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

### **PART 3 - EXECUTION (NOT USED)**

- END OF SECTION -

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## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. **This Section includes Testing, Adjusting, and Balancing (TAB) to produce design objectives for the following:**

1. Air Systems:
  - a. Variable-air-volume systems.
  - b. Ventilation and exhaust systems.
2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Strategies and Procedures Plan:** Within 30 days from CONTRACTOR's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- C. **Certified TAB Reports:** Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- D. Warranties specified in this Section.

#### 1.3 QUALITY ASSURANCE

- A. **TAB Firm Qualifications:** Engage a TAB firm certified by AABC, NEBB or TABB or approved by the ENGINEER.
1. The CONTRACTOR shall submit the name and credentials of the TAB firm for review and approval within 30 days after signing the construction contract.
    - a. The TAB firm shall provide qualifications of the firm and of both the individual who is to do the test and balance. Provide proof of completed balancing work on at least five projects of similar size and scope, along with a list of references which may verify qualifications.
    - b. Final approval of the TAB firm will be at the ENGINEER's discretion, based on the information submitted.

- B. **Certification of TAB Reports:** Certify TAB field data reports. This certification includes the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. **TAB Report Forms:** Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

#### 1.4 PROJECT CONDITIONS

- A. **Partial Owner Occupancy:** OWNER may occupy completed areas of building before Substantial Completion. Cooperate with OWNER during TAB operations to minimize conflicts with OWNER's operations.

#### 1.5 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

### PART 2 - PRODUCTS (NOT USED)

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
  - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible, and their controls are connected and functioning.
- L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- M. Examine strainers for clean screens and proper perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine equipment for installation and for properly operating safety interlocks and controls.
- R. **Examine automatic temperature system components to verify the following:**
  - 1. Dampers, valves, and other controlled devices are operated by the intended controller.



2. Dampers and valves are in the position indicated by the controller.
  3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  6. Sensors are located to sense only the intended conditions.
  7. Sequence of operation for control modes is according to the Contract Documents.
  8. Controller set points are set at indicated values.
  9. Interlocked systems are operating.
  10. Changeover from heating to cooling mode occurs according to indicated values.
- S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
  2. Hydronic systems are filled, clean, and free of air.
  3. Automatic temperature-control systems are operational.
  4. Equipment and duct access doors are securely closed.
  5. Balance, smoke, and fire dampers are open.
  6. Isolating and balancing valves are open and control valves are operational.
  7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  8. Windows and doors can be closed so indicated conditions for system operations can be met.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

### 3.5 PROCEDURES FOR EXHAUST SYSTEMS SYSTEM AND VENTILATION FAN SYSTEMS.

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  2. Measure static pressure across each component that makes up the system.
  3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
  4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
  5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
- C. Measure inlets without making adjustments.
- D. Adjust inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers.
- ### 3.6 PROCEDURES FOR MOTORS
- A. **Motors, 1/2 HP and Larger:** Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
  2. Motor horsepower rating.
  3. Motor rpm.

4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. **Motors Driven by Variable-Frequency Controllers:** Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

### 3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

### 3.9 TEMPERATURE-CONTROL VERIFICATION

- A. The temperature control system test and report shall be performed by the temperature control contractor.
- B. Verify that controllers are calibrated and commissioned.
- C. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- D. Record controller settings and note variances between set points and actual measurements.
- E. Check the operation of limiting controllers (i.e. high- and low-temperature controllers).
- F. Check free travel and proper operation of control devices such as damper and valve operators.

- G. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- H. Check the interaction of electrically operated switch transducers.
- I. Check the interaction of interlock and lockout systems.
- J. Check main control supply-air pressure and observe compressor and dryer operations.
- K. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
- L. Note operation of electric actuators using spring return for proper fail-safe operations.

### 3.10 TOLERANCES

- A. **Set HVAC system airflow and water flow rates within the following tolerances:**
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
  - 2. Air Outlets and Inlets: 0 to minus 10 percent.
  - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
  - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

### 3.11 FINAL REPORT

- A. **General:** Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing ENGINEER.
  - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. **Final Report Contents:** In addition to certified field report data, include the following:
  - 1. Fan curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. **General Report Data:** In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. ENGINEER's name and address.
7. CONTRACTOR's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
  - a. Indicated versus final performance.
  - b. Notable characteristics of systems.
  - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
  - a. Settings for outside-, return-, and exhaust-air dampers.
  - b. Conditions of filters.
  - c. Cooling coil, wet- and dry-bulb conditions.
  - d. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Inlet vane settings for variable-air-volume systems.

- g. Settings for supply-air, static-pressure controller.
  - h. Other system operating conditions that affect performance.
- E. **System Diagrams:** Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outside, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.

### 3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

- END OF SECTION -

## SECTION 23 07 00 - HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Insulation Materials:
  - a. Cellular glass
  - b. Flexible elastomeric
  - c. Mineral fiber
  - d. Polyolefin
2. Fire-rated insulation systems:
3. Insulating cements
4. Adhesives
5. Mastics
6. Sealants
7. Factory-applied jackets
8. Field-applied fabric-reinforcing mesh
9. Field-applied jackets
10. Tapes
11. Securements
12. Corner angles

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Product Data:** For each type of product indicated.
- C. **Shop Drawings:**
  1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.



2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

D. Field quality-control reports.

### 1.3 QUALITY ASSURANCE

- A. **Fire-Test-Response Characteristics:** Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. **Cellular Glass:** Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Pittsburgh Corning Corporation; Foamglas Super K.
  2. Block Insulation: ASTM C552, Type I.
  3. Special-Shaped Insulation: ASTM C552, Type III.
  4. Board Insulation: ASTM C552, Type IV.
  5. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
  6. Preformed Pipe Insulation with Factory-Applied [ASJ-SSL]: Comply with ASTM C552, Type II, Class 2.
  7. Factory fabricate shapes according to ASTM C450 and ASTM C585.
- G. **Flexible Elastomeric:** Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
- H. **Mineral-Fiber Blanket Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Owens Corning; All-Service Duct Wrap.
- I. **High-Temperature, Mineral-Fiber Blanket Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Johns Manville; HTB 23 Spin-Glas.
  - b. Owens Corning; High Temperature Flexible Batt Insulations.
- J. **Mineral-Fiber Board Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied AS. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.
    - e. Owens Corning; Fiberglas 700 Series.
- K. **High-Temperature, Mineral-Fiber Board Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; FBX.
    - b. Johns Manville; 1000 Series Spin-Glas.
    - c. Owens Corning; High Temperature Industrial Board Insulations.
    - d. Rock Wool Manufacturing Company; Delta Board.
    - e. Roxul Inc.; Roxul RW.
    - f. Thermafiber; Thermafiber Industrial Felt.
- L. **Mineral-Fiber, Preformed Pipe Insulation:**
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.

- b. Johns Manville; Micro-Lok.
  - c. Knauf Insulation; 1000 Pipe Insulation.
  - d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- M. **Mineral-Fiber, Pipe and Tank Insulation:** Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied (ASJ) complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; CrimpWrap.
    - b. Johns Manville; Micro-Flex.
    - c. Knauf Insulation; Pipe and Tank Insulation.
    - d. Owens Corning; Fiberglas Pipe and Tank Insulation.
- N. **Polyolefin:** Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534 or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Armacell LLC; Tubolit.
    - b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
    - c. RBX Corporation; Therma-cell.

## 2.2 INSULATING CEMENTS

- A. **Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:** Comply with ASTM C449/C449M.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Insulco, Division of MFS, Inc.; SmoothKote.

- b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
- c. Rock Wool Manufacturing Company; Delta One Shot.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. **Flexible Elastomeric and Polyolefin Adhesive:** Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA Inc.; Aero seal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H.B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
- C. **Mineral-Fiber Adhesive:** Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H.B. Fuller Company; 85-20.
- D. **ASJ Adhesive, and FSK and PVDC Jacket Adhesive:** Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H.B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
- E. **PVC Jacket Adhesive:** Compatible with PVC jacket.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Chemical Company (The); 739, Dow Silicone.
- b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Red Devil, Inc.; Celulon Ultra Clear.
- e. Speedline Corporation; Speedline Vinyl Adhesive.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. **Breather Mastic:** Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H.B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.

## 2.5 SEALANTS

- A. **Joint Sealants:**
  - 1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-76.
    - b. Foster Products Corporation, H.B. Fuller Company; 30-45.
    - c. Pittsburgh Corning Corporation; Pittseal 444.
- B. **FSK and Metal Jacket Flashing Sealants:**
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Childers Products, Division of ITW; CP-76-8.
- b. Foster Products Corporation, H.B. Fuller Company; 95-44.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.

**C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:**

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-76.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.

**2.6 FACTORY-APPLIED JACKETS**

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

**2.7 FIELD-APPLIED JACKETS**

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. **PVC Jacket:** High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.

- d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: Color-code jackets based on system.
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
  - 5. Factory-fabricated tank heads and tank side panels.
- D. **Aluminum Jacket:** Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Sheet and roll stock ready for shop or field sizing.
  - 3. Finish and thickness are indicated in field-applied jacket schedules.
  - 4. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - 5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - 6. Factory-Fabricated Fitting Covers:
    - a. Same material, finish, and thickness as jacket.
    - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - c. Tee covers.
    - d. Flange and union covers.
    - e. End caps.
    - f. Beveled collars.
    - g. Valve covers.



- h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. **Self-Adhesive Outdoor Jacket:** 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Polyguard; Alumaguard 60.
- F. **PVDC Jacket for Indoor Applications:** 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- G. **PVDC Jacket for Outdoor Applications:** 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- H. **PVDC-SSL Jacket:** PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

## 2.8 TAPES

- A. **ASJ Tape:** White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.

- b. Compac Corp.; 104 and 105.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
  - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
- B. **FSK Tape:** Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
- C. **PVC Tape:** White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - d. Venture Tape; 1506 CW NS.
- D. **Aluminum-Foil Tape:** Vapor-retarder tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
- E. **PVDC Tape for Indoor Applications:** White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
- F. **PVDC Tape for Outdoor Applications:** White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.

## 2.9 SECUREMENTS

- A. **Aluminum Bands:** ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 3/4-inch wide with wing or closed seal.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Products; Bands.
    - b. PABCO Metals Corporation; Bands.
    - c. RPR Products, Inc.; Bands.
- B. **Insulation Pins and Hangers:**
  - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - 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) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      - 2) GEMCO; Perforated Base.
      - 3) Midwest Fasteners, Inc.; Spindle.
  - 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - 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) GEMCO; Nylon Hangers.
      - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - 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) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      - 2) GEMCO; Press and Peel.
      - 3) Midwest Fasteners, Inc.; Self Stick.
  4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - 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) AGM Industries, Inc.; RC-150.
      - 2) GEMCO; R-150.
      - 3) Midwest Fasteners, Inc.; WA-150.
      - 4) Nelson Stud Welding; Speed Clips.
    - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - 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) GEMCO.
      - 2) Midwest Fasteners, Inc.
- C. **Staples:** Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. **Wire:** 0.062-inch, stainless steel.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. C & F Wire.
- b. Childers Products.
- c. PABCO Metals Corporation.
- d. RPR Products, Inc.

## 2.10 CORNER ANGLES

- A. **PVC Corner Angles:** 30-mils-thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. **Aluminum Corner Angles:** 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. **Surface Preparation:** Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.

- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. **Install insulation with factory-applied jackets as follows:**
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

**P. For above ambient services, do not install insulation to the following:**

- 1. Vibration-control devices.
- 2. Testing agency labels and stamps.
- 3. Nameplates and data plates.
- 4. Manholes.
- 5. Handholes.
- 6. Cleanouts.

### 3.3 PENETRATIONS

**A. Insulation Installation at Roof Penetrations:** Install insulation continuously through roof penetrations.

- 1. Seal penetrations with flashing sealant.
- 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
- 4. Seal jacket to roof flashing with flashing sealant.

**B. Insulation Installation at Underground Exterior Wall Penetrations:** Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

**C. Insulation Installation at Aboveground Exterior Wall Penetrations:** Install insulation continuously through wall penetrations.

- 1. Seal penetrations with flashing sealant.
- 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
- 4. Seal jacket to wall flashing with flashing sealant.

D. **Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):** Install insulation continuously through walls and partitions.

E. **Insulation Installation at Fire-Rated Wall and Partition Penetrations:** Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" Firestopping and fire-resistive joint sealers.

F. **Insulation Installation at Floor Penetrations:**

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.

2. Pipe: Install insulation continuously through floor penetrations.

3.4 Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. **Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels:** Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
  - a. Do not weld anchor pins to ASME-labeled pressure vessels.
  - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
  - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not overcompress insulation during installation.



- e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
  - f. Impale insulation over anchor pins and attach speed washers.
  - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. **Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels:** Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. **Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:**

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by

tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 CELLULAR-GLASS INSULATION INSTALLATION

**A. Insulation Installation on Straight Pipes and Tubes:**

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

**B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

**3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION**

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**B. Insulation Installation on Pipe Flanges:**

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**3.8 MINERAL-FIBER INSULATION INSTALLATION**

**A. Insulation Installation on Straight Pipes and Tubes:**

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

**B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

**E. Blanket Insulation Installation on Ducts and Plenums:** Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation

segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

**F. Board Insulation Installation on Ducts and Plenums:** Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.9 POLYOLEFIN INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.



2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

**3.10 FIELD-APPLIED JACKET INSTALLATION**

**A. Where FSK jackets are indicated, install as follows:**

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

**B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.**

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

**C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.**

**D. Where PVDC jackets are indicated, install as follows:**

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an

approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

**B. Tests and Inspections:**

1. Inspect ductwork, randomly selected by ENGINEER, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by ENGINEER, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by ENGINEER, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.12 DUCT INSULATION SCHEDULE, GENERAL

**A. Plenums and Ducts Requiring Insulation:**

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.
7. Outdoor, Exhaust duct carrying moist or humid air.

**B. Items Not Insulated:**

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

### 3.13 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

**A. Concealed or exposed, Supply Air Duct, Return Air Duct and Outside Air Duct:**

1. Insulation for concealed and round ducts shall be Type 75 fiberglass duct wrap, 2" thick with foil reinforced Kraft jacket.
2. Insulation for exposed rectangular ducts shall be Type 703 rigid fiberglass board, 1-1/2" thick with ASJ25 white Kraft foil laminate facing. Ductwork shall be considered exposed in all cases where it is not enclosed in shafts or is not located above hard or lay-in ceilings.

### 3.14 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is CONTRACTOR's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. **Heat-Exchanger (Water-to-Water for Heating Service) Insulation:** Mineral-fiber pipe and tank, 2 inches.

- D. **Heating-Hot-Water Expansion/Compression Tank Insulation:** Mineral-Fiber Pipe and Tank: 1 inch thick.
- E. **Heating-Hot-Water Air-Separator Insulation:** Mineral-Fiber Pipe and Tank: 2 inches thick.

### 3.15 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is CONTRACTOR's option.
- B. **Items Not Insulated:** Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.16 INDOOR PIPING INSULATION SCHEDULE

- A. **Heating-Hot-Water Supply and Return, 200 Deg F and below:** Insulation shall be Owens-Corning Fiberglass 25 ASJ/SSL or equal:

Pipe Size	Insulation Thickness
1-1/2" & under	1-1/2"
2" – 4"	2"
5" – 6"	2-1/2"

- B. **Chilled Water, above 40 Deg F:** Insulation shall be Owens-Corning Fiberglass 25 ASJ/SSL or equal:

Pipe Size	Insulation Thickness
1-1/2" & under	1-1/2"
2" – 4"	1-1/2"

- C. **Refrigerant Suction and Hot-Gas Piping:** Flexible elastomeric, 1-1/2 inch thick.

### 3.17 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. **Heating-Hot-Water Supply and Return, 200 Deg F and below:** Insulation shall be Owens-Corning Fiberglass 25 ASJ/SSL or equal:

Pipe Size	Insulation Thickness
-----------	----------------------

1-1/2" & under	1-1/2"
2" – 4"	2"
5" – 6"	2-1/2"

- B. **Chilled Water, above 40 Deg F:** Insulation shall be Owens-Corning Fiberglass 25 ASJ/SSL or equal:

Pipe Size	Insulation Thickness
1-1/2" & under	1-1/2"
2"-4"	1-1/2"

- C. **Refrigerant Suction and Hot-Gas Piping:** Insulation shall be one of the following:

1. Flexible Elastomeric: 2 inches thick.

### 3.18 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.
- B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.
- C. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F and below: Cellular glass, 3 inches thick.

### 3.19 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is CONTRACTOR's option.

C. **Ducts and Plenums, Concealed:**

1. None.

D. **Ducts and Plenums, Exposed:**

1. None.

E. **Equipment, Concealed:**

1. None.

F. **Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:**

1. Hot equipment shall be insulated with Type 700 Series fiberglass board, 2" thick, unfaced with 8-ounce canvas jacket applied with a white adhesive such as Aerbol meeting flame spread and smoke restrictions as listed.

**G. Piping, Concealed:**

1. None.

**H. Piping, Exposed:**

1. Any insulated piping which spans mechanical rooms less than 18" above the floor shall be covered with metal jacket. Jacket material shall be one of the following:
  - a. Aluminum, embossed, 0.016" thick with stainless steel tie-bands.
  - b. Stainless steel, smooth surface, 0.010" thick with stainless steel tie bands.

**3.20 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is CONTRACTOR's option.

**C. Piping, Exposed:**

1. Aluminum, embossed, .016" thick with stainless steel tie-bands.
2. Stainless steel, smooth surface, 0.010" thick with stainless steel tie bands.
3. Fittings shall be covered with pre-formed metal jackets.

**3.21 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET**

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

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## SECTION 23 23 00 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

#### 1.2 PERFORMANCE REQUIREMENTS

##### A. **Line Test Pressure for Refrigerant R-410A:**

1. Suction Lines for Air-Conditioning Applications: 300 psig
2. Suction Lines for Heat-Pump Applications: 535 psig
3. Hot-Gas and Liquid Lines: 535 psig

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Product Data:** For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- C. **Shop Drawings:** Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASHRAE 34, "Refrigeration Systems and Designation and Safety Classification of Refrigerants."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."



## 1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. **Copper Tube:** ASTM B88, Type K or L.
- B. **Wrought-Copper Fittings:** ASME B16.22.
- C. **Wrought-Copper Unions:** ASME B16.22.
- D. **Solder Filler Metals:** ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. **Brazing Filler Metals:** AWS A5.8.
- F. **Flexible Connectors:**
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

### 2.2 VALVES AND SPECIALTIES

- A. **Diaphragm Packless Valves:**
  - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
  - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
  - 3. Operator: Rising stem and hand wheel.
  - 4. Seat: Nylon.
  - 5. End Connections: Socket, union, or flanged.
  - 6. Working Pressure Rating: 500 psig.
  - 7. Maximum Operating Temperature: 275 deg F.

**B. Packed-Angle Valves:**

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

**C. Check Valves:**

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

**D. Service Valves:**

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

**E. Solenoid Valves:** Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
  2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-VAC coil.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
  8. Manual operator.
- F. **Safety Relief Valves:** Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
  2. Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Seat Disc: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Working Pressure Rating: 400 psig.
  6. Maximum Operating Temperature: 240 deg F.
- G. **Thermostatic Expansion Valves:** Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
  2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  5. Suction Temperature: 40 deg F.
  6. Superheat: Adjustable.
  7. Reverse-flow option (for heat-pump applications).
  8. End Connections: Socket, flare, or threaded union.
  9. Working Pressure Rating: 450 psig.

**H. Straight-Type Strainers:**

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

**I. Angle-Type Strainers:**

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

**J. Moisture/Liquid Indicators:**

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

**K. Replaceable-Core Filter Dryers: Comply with ARI 730.**

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated.

4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow:
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. **Permanent Filter Dryers:** Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow:
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. **Liquid Accumulators:** Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

## 2.3 REFRIGERANTS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. **Atofina Chemicals, Inc.**
2. **DuPont Company; Fluorochemicals Div.**
3. **Honeywell, Inc.; Genetron Refrigerants.**
4. **INEOS Fluor Americas LLC.**

B. ASHRAE 34, R-410A.

## **PART 3 - EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Suction Lines NPS 4 NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. **Hot-Gas and Liquid Lines:** Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

### **3.2 VALVE AND SPECIALTY APPLICATIONS**

- A. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- B. Install a check valve at the compressor discharge.
- C. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- D. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  1. Install valve so diaphragm case is warmer than bulb.
  2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- E. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- G. **Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:**
  1. Solenoid valves.

- 2. Thermostatic expansion valves.
- 3. Compressor.
- H. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- I. Install flexible connectors at compressors.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 23 09 00 – Instrumentation and Control for HVAC and for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 – Access Doors and Frames if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. **Slope refrigerant piping as follows:**

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  2. Install horizontal suction lines with a uniform slope downward to compressor.
  3. Install traps and double risers to entrain oil in vertical runs.
  4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Seal penetrations through fire and smoke barriers according to Section 07 84 13 – Penetration Firestopping.
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- U. Seal pipe penetrations through exterior walls according to Section 07 92 00 – Sealants and Caulking for materials and methods.

3.4 **PIPE JOINT CONSTRUCTION**

- A. **Soldered Joints:** Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."
- B. **Brazed Joints:** Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 **HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor products are specified in Section 22 05 29 – Hangers and Support for Plumbing Piping and Equipment.
- B. **Install the following pipe attachments:**
1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.



3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

**C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:**

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

**D. Support multifloor vertical runs at least at each floor.**

**3.6 FIELD QUALITY CONTROL**

**A. Perform tests and inspections and prepare test reports.**

**B. Tests and Inspections:**

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
  - a. Fill system with nitrogen to the required test pressure.
  - b. System shall maintain test pressure at the manifold gage throughout duration of test.
  - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

- d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

### 3.7 SYSTEM CHARGING

#### A. **Charge system using the following procedures:**

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

### 3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. **Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:**
  1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

- END OF SECTION -

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## SECTION 23 31 13 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. **Section Includes:**

1. Rectangular ducts and fittings
2. Round ducts and fittings
3. Sheet metal materials
4. Sealants and gaskets
5. Hangers and supports
6. Seismic-restraint devices

#### 1.2 PERFORMANCE REQUIREMENTS

- A. **Delegated Duct Design:** Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and performance requirements and design criteria indicated. All ductwork main runs shall be pressure tested to verify they meet the required static pressure class for the ductwork system. All duct pressure testing will be performed and scheduled with the owner's representative. Once complete the CONTRACTOR will provide signed copies of the pressure test results bearing the CONTRACTOR'S and owners rep's signatures. All reports will be dated showing the date and time the pressure testing was conducted.

##### 1. Static-Pressure Classes:

- a. Supply Ducts (Upstream from Air Terminal Units): 2.5-inch wg.
- b. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
- c. Supply Ducts (in Mechanical Equipment Rooms): 2.5-inch wg.
- d. Return Ducts (Negative Pressure): 1-inch wg.
- e. Exhaust Ducts (Negative Pressure): 1-inch wg.

##### 2. Leakage Class:

- a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
- b. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
- c. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

- B. **Structural Performance:** Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." All Seismic calculations to be stamp and sealed by a licensed professional engineer that is licensed in the state the project is located in.

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

- B. **Product Data:** For each type of product indicated.

- C. **Shop Drawings:**

1. Fittings.
2. Reinforcement and spacing.
3. Seam and joint construction.
4. Penetrations through fire-rated and other partitions.
5. Equipment installation based on equipment being used on Project.
6. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

- D. **Delegated-Design Submittal:**

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers, supports, and seismic restraints.

- E. Welding certificates.

## 1.4 QUALITY ASSURANCE

### A. **Welding Qualifications:** Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code – Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code – Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

## PART 2 - PRODUCTS

### 2.1 RECTANGULAR DUCTS AND FITTINGS

- A. **General Fabrication Requirements:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. **Transverse Joints:** Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- C. **Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 1-5, "Longitudinal Seams – Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- D. **Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction:** Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

### 2.2 ROUND DUCTS AND FITTINGS

- A. **General Fabrication Requirements:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. **Lindab Inc.**
    - b. **McGill AirFlow LLC.**
    - c. **SEMCO Incorporated.**

- d. **Sheet Metal Connectors, Inc.**
  - e. **Spiral Manufacturing Co., Inc.**
- B. **Transverse Joints:** Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-2, "Transverse Joints – Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. **Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-1, "Seams – Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.
- D. **Tees and Laterals:** Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. **General Material Requirements:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. **Galvanized Sheet Steel:** Comply with ASTM A653/A653M.
- 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. **Carbon-Steel Sheets:** Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. **Stainless-Steel Sheets:** Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

- E. **Aluminum Sheets:** Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. **Reinforcement Shapes and Plates:** ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. **Tie Rods:** Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 SEALANT AND GASKETS

- A. **General Sealant and Gasket Requirements:** Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. **Two-Part Tape Sealing System:**
  - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  - 2. Tape Width: 3 inches.
  - 3. Sealant: Modified styrene acrylic.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  - 7. Service: Indoor and outdoor.
  - 8. Service Temperature: Minus 40 to plus 200 deg F.
  - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. **Water-Based Joint and Seam Sealant:**
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Water resistant.



5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

**D. Flanged Joint Sealant:** Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

**E. Flange Gaskets:** Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

**F. Round Duct Joint O-Ring Seals:**

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments:** Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments:** Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts:** Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts:** Stainless steel complying with ASTM A492.

- F. **Steel Cable End Connections:** Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. **Duct Attachments:** Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. **Trapeze and Riser Supports:**
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.6 SEISMIC-RESTRAINT DEVICES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. **Cooper B-Line, Inc.; a division of Cooper Industries.**
  - 2. **Ductmate Industries, Inc.**
  - 3. **Hilti Corp.**
  - 4. **Kinetics Noise Control.**
  - 5. **Loos & Co.; Cableware Division.**
  - 6. **Mason Industries.**
  - 7. **TOLCO; a brand of NIBCO INC.**
  - 8. **Unistrut Corporation; Tyco International, Ltd.**
- B. **General Requirements for Restraint Components:** Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. **Channel Support System:** Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

- D. **Restraint Cables:** ASTM A603, galvanized -steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. **Hanger Rod Stiffener:** Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- F. **Mechanical Anchor Bolts:** Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.
- G. All Seismic calculations to be stamp and sealed by a licensed professional engineer that is licensed in the state the project is located in.

## **PART 3 - EXECUTION**

### **3.1 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
- M. The use of "Bull Head" style Taps and Tees is not allowed with the ENGINEERS approval.

### 3.2 SEAM AND JOINT SEALING

- A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.
- B. **Seal Classes:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."

### 3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. **Building Attachments:** Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. **Hanger Spacing:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. **Hangers Exposed to View:** Threaded rod and angle or channel supports.

- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
  - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
  - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. **Attachment to Structure:** If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. **Drilling for and Setting Anchors:**
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.

5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 DUCT SCHEDULE

#### A. **Fabricate ducts with galvanized sheet steel except as follows:**

1. Moist Environment Ducts: Aluminum or Stainless Steel at Contractors option

#### B. **Intermediate Reinforcement:**

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts: Galvanized steel.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

#### C. **Elbow Configuration:**

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1,000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1,000 to 1,500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - c. Velocity 1,500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

- 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-3, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1,000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1,000 to 1,500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1,500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

**D. Branch Configuration:**

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry or high efficiency style taps
  - b. Rectangular Main to Round Branch: Spin in or saddle style taps
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1,000 fpm or Lower: 90-degree tap.
  - b. Velocity 1,000 to 1,500 fpm: Conical tap.
  - c. Velocity 1,500 fpm or Higher: 45-degree lateral.

- END OF SECTION -

## SECTION 23 33 00 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. **Section Includes:**

1. Backdraft and pressure relief dampers
2. Manual volume dampers
3. Control dampers
4. Fire dampers
5. Smoke dampers
6. Fire / Smoke dampers
7. Flange connectors
8. Turning vanes
9. Duct-mounted access doors
10. Flexible connectors
11. Flexible ducts
12. Duct accessory hardware
13. Louvers and penthouses

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Product Data:** For each type of product indicated.
- C. **Shop Drawings:** For duct accessories. Include plans, elevations, sections, details and attachments to other work.
  1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.



- c. Control damper installations.
    - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
    - e. Wiring Diagrams: For power, signal, and control wiring.
  - D. Operation and maintenance data.
- 1.3 QUALITY ASSURANCE
- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
  - B. Comply with AMCA 500-D testing for damper rating.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. **Galvanized Sheet Steel:** Comply with ASTM A653/A653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. **Stainless-Steel Sheets:** Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- D. **Aluminum Sheets:** Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. **Extruded Aluminum:** Comply with ASTM B221, Alloy 6063, Temper T6.
- F. **Reinforcement Shapes and Plates:** Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. **Tie Rods:** Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. **American Warming and Ventilating**
2. **Greenheck Fan Corporation**
3. **Lloyd Industries, Inc.**
4. **Nailor Industries Inc.**
5. **NCA Manufacturing, Inc.**
6. **Pottorff; a division of PCI Industries, Inc.**
7. **Ruskin Company**
8. **SEMCO Incorporated**
9. **Vent Products Company, Inc.**

B. **Description:** Gravity balanced.

C. **Frame:** galvanized sheet steel, with welded corners and mounting flange.

D. **Blades:** Multiple single-piece blades, maximum 6-inch width, with sealed edges.

E. **Blade Action:** Parallel.

F. **Return Spring:** Adjustable tension.

G. **Accessories:**

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Front of rear screens.
6. 90-degree stops.

H. **Sleeve:** Minimum 20-gage thickness.

## 2.3 MANUAL VOLUME DAMPERS

A. **Standard, Steel, Manual Volume Dampers:**

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. **American Warming and Ventilating; a division of Mestek, Inc.**
  - b. **Flexmaster U.S.A., Inc.**
  - c. **McGill AirFlow LLC.**
  - d. **METALAIRE, Inc.**
  - e. **Nailor Industries Inc.**
  - f. **Penn**
  - g. **Ruskin Company**
  - h. **Vent Products Company, Inc.**
  - i. **NCA Manufacturing, Inc.**
- 2. Standard leakage rating
  - 3. Suitable for horizontal or vertical applications.
  - 4. Basis of Design:
    - a. Rectangular dampers may be single blade up to 24"x12" size and multiple, opposed blade design for larger sizes. Control shaft shall be solid 3/8" square or hex steel with synthetic or bronze bearings. Provide with 2" stand-off bracket and manual quadrant operator. Provide Ruskin model CD-15 or approved equal, rated for 1,500 FPM velocity and 2-1/2" static pressure differential.
    - b. Round dampers shall have solid 3/8" or 1/2" square or hex steel shaft with synthetic or bronze bearings. Provide with 2" operator stand-off bracket and manual quadrant operator. Provide Ruskin model CDRS25 or approved equal, rated for 1,500 FPM velocity.
    - c. All damper blades shall be secured to damper axles by mechanical (threaded) fasteners or by welding. Shop fabricated dampers are not acceptable.
    - d. Combination spin-ins with dampers are acceptable only if damper requirements listed herein are met. If damper requirements cannot be met by combination units, provide separate spin-in and volume damper.

## 2.4 CONTROL DAMPERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. **American Warming and Ventilating; a division of Mestek, Inc.**
  - 2. **Duro Dyne Inc.**

3. **Flexmaster U.S.A., Inc.**
4. **Greenheck Fan Corporation**
5. **Lloyd Industries, Inc.**
6. **McGill AirFlow LLC.**
7. **METALAIRE, Inc.**
8. **Metal Form Manufacturing, Inc.**
9. **Nailor Industries Inc.**
10. **Ruskin Company**
11. **Vent Products Company, Inc.**
12. **Young Regulator Company**
13. **NCA Manufacturing, Inc.**

**B. Basis of Design:**

1. Motorized dampers shall be Ruskin CD-50 or CD-40 low leakage damper with airfoil blades and vinyl double edge seals or Johnson Controls D1300 with edge seals. Dampers shall be opposed blade unless otherwise noted. Substitute units shall be AMCA certified as a low leakage damper and shall be equal to the models specified above in construction, features and quality. Damper actuators shall be provided under temperature control unless otherwise scheduled or noted on plans.

**2.5 FIRE DAMPERS**

- A. Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. **Air Balance Inc.; a division of Mestek, Inc.**
2. **Greenheck Fan Corporation.**
3. **McGill AirFlow LLC.**
4. **METALAIRE, Inc.**
5. **Nailor Industries Inc.**
6. **Penn**
7. **Pottorff; a division of PCI Industries, Inc.**

8. **Prefco; Perfect Air Control, Inc.**

9. **Ruskin Company.**

10. **Vent Products Company, Inc.**

11. **Or Equal**

B. **Type:** Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4,000-fpm velocity.

D. **Fire Rating:** 1-1/2 and 3 hours.

E. Basis of Design:

1. Fire dampers shall be Ruskin dynamic curtain type DIBD2 Style B with 1-1/2-hour UL label, or approved equal. Where space does not permit installation of Style B, then Style A shall be used.

2. Fire dampers shall be furnished with factory sleeve; wall angles and 212-degree F fusible links to conform to U.L. tested and approved mounting means. Provide complete mounting details to the Contractor.

3. Fire dampers installed in flanged duct systems (Duct Mate) shall be furnished with Duct Mate break-away connections.

## 2.6 SMOKE DAMPERS

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. **Air Balance Inc.; a division of Mestek, Inc.**

2. **Greenheck Fan Corporation.**

3. **Nailor Industries Inc.**

4. **Penn**

5. **Ruskin Company Manufacturers**

B. **General Requirements:** Label according to UL 555S by an NRTL

C. **Basis of Design:** Ruskin SD50 or SDS25

1. Damper to be power open / fail close with 120 V actuator.

2. Smoke dampers shall be furnished with factory sleeves and wall angles to conform to U.L. tested and approved mounting means. Provide complete mounting details to the Contractor.
  3. Smoke dampers installed in flanged duct systems (Duct Mate systems) shall be furnished with Duct Mate break-away connections.
- D. **Smoke Detector:** Integral, factory wired for single-point connection.
- E. **Frame:** fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. **Blades:** Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- G. **Leakage:** Class I.
- H. Rated pressure and velocity to exceed design airflow conditions.
- I. **Mounting Sleeve:** Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- J. **Damper Motors:** two-position action.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
  3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
  7. Electrical Connection: 115 V, single phase, 60 Hz.

L. **Accessories:**

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, damper, or remote mounted as required.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

1. **Air Balance Inc.; a division of Mestek, Inc.**
2. **Cesco Products; a division of Mestek, Inc.**
3. **Greenheck Fan Corporation**
4. **Nailor Industries Inc.**
5. **Ruskin Company**

B. **Type:** Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4,000-fpm velocity.

D. **Fire Rating:** 1-1/2 and 3 hours.

E. **Frame:** Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. **Heat-Responsive Device:** Electric resettable link and switch package, factory installed, rated.

G. **Smoke Detector:** Integral, factory wired for single-point connection.

H. **Blades:** Airfoil-shaped, double-skin, single piece construction with 14 gage equivalent thickness, maximum 6" wide.

I. Rated pressure and velocity to exceed design airflow conditions.

J. **Mounting Sleeve:** Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. **Motor Sizes:** Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

**L. Accessories:**

1. Auxiliary switches for signaling.
2. Test and reset switches, remote mounted.

## 2.8 FLANGE CONNECTORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. **Ductmate Industries, Inc.**
  2. **Nexus PDQ; Division of Shilco Holdings Inc.**
  3. **Ward Industries, Inc.; a division of Hart & Cooley, Inc.**
- B. **Description:** roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. **Material:** Galvanized steel.
- D. **Gage and Shape:** Match connecting ductwork.

## 2.9 TURNING VANES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. **Ductmate Industries, Inc.**
  2. **Duro Dyne Inc.**



3. **METALAIRE, Inc.**
  4. **SEMCO Incorporated.**
  5. **Ward Industries, Inc.; a division of Hart & Cooley, Inc.**
- B. **Turning Vanes for Metal Ducts:** Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. **Acoustic Turning Vanes:** Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. **Manufactured Turning Vanes for Nonmetal Ducts:** Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. **General Requirements:** Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. **Vane Construction:** Single wall for ducts up to 36 inches wide and double wall for larger dimensions.

## 2.10 DUCT-MOUNTED ACCESS DOORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. **American Warming and Ventilating; a division of Mestek, Inc.**
  2. **Cesco Products; a division of Mestek, Inc.**
  3. **Ductmate Industries, Inc.**
  4. **Flexmaster U.S.A., Inc.**
  5. **Greenheck Fan Corporation**
  6. **McGill AirFlow LLC**
  7. **Nailor Industries Inc.**
  8. **Pottorff; a division of PCI Industries, Inc.**
  9. **Ventfabrics, Inc.**
  10. **Ward Industries, Inc.; a division of Hart & Cooley, Inc.**
- B. **Duct-Mounted Access Doors:** Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels – Round Duct."

1. Basis of Design: Ruskin #ADC3 with cam type closers. Use largest standard square size acceptable by duct.
2. Door:
  - a. Double wall, rectangular.
  - b. Latches: cam latches.
  - c. Fabricate doors airtight and suitable for duct pressure class.
3. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

## 2.11 FLEXIBLE CONNECTORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. **Ductmate Industries, Inc.**
  2. **Duro Dyne Inc.**
  3. **Ventglass, Inc.**
  4. **Ward Industries, Inc.; a division of Hart & Cooley, Inc.**
- B. **Materials:** Flame-retardant or noncombustible fabrics.
- C. **Coatings and Adhesives:** Comply with UL 181, Class 1.
- D. **Metal-Edged Connectors:** Factory fabricated with a fabric strip attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets to provide 4" metal-to-metal separation. Provide metal compatible with connected ducts.

## 2.12 FLEXIBLE DUCTS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. **Flexmaster U.S.A., Inc.**
  2. **McGill AirFlow LLC.**
  3. **Ward Industries, Inc.; a division of Hart & Cooley, Inc.**
- B. **Insulated, Flexible Duct:** Shall be Thermalflex Type M-KE, Hart & Cooley, Flex Master or as approved. Duct shall be in accord with NFPA 90A requirements and shall be UL approved and rated for flame spread less than 25 smoke development not more than 50.

Pressure rated for 6 inches WG. Flexible duct shall be insulated with an R value of not less than 5 and shall be manufactured with a fiberglass reinforced vapor barrier jacket.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4,000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

**C. Flexible Duct Connectors:**

1. Bands for securing flexible duct core liner to sheet metal connectors shall be stainless steel draw bands with screw operators. Bands for securing outer insulation jacket shall be stainless steel draw bands or may be nylon "zip-ties" not less than 1/4" in width made specifically for the purpose.
2. Sealant tape for sealing the core liner to sheet metal connectors shall be "FoilGirp" as manufactured by Hardcast or approved equivalent product. Tape shall have a 2-mil aluminum foil facing with a modified BUTYL adhesive and shall be rated for SMACNA seal classes A, B, and C for duct static pressures up to 6" w.g. for a temperature range of -20°F to 220°F. tape shall be 2" in width and shall have a flamespread rating of less than 25 and a smoke development rating of less than 50. Submit complete product literature for sealing tapes.

**2.13 DUCT ACCESSORY HARDWARE**

- A. **Instrument Test Holes:** Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. **Adhesives:** High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

**2.14 LOUVERS AND PENTHOUSES**

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. **Airolite**
  2. **Airstream**
  3. **American Warming & Ventilating**
  4. **Carnes**
  5. **Perfco**
  6. **Ruskin**
  7. **United Sheet Metal**

- B. Sizes, materials, types and finishes shall be as noted in the schedules or elsewhere on the drawings. Substitute louvers shall not have less free area than the specified units.
- C. All louvers furnished for mounting in masonry wall construction shall be furnished with an extended or separate sill.
- D. Unless indicated otherwise, all louvers from masonry walls will be box frame without face flange.
- E. Penthouse units shall be provided with factory or field fabricated curbs as required or shown on the plans. Curbs shall take into account the pitch of the roof to provide a level surface/frame for mounting of the penthouse.
- F. Penthouses shall be furnished with special materials, finishes, bird screens, snow screens, backdraft dampers, insulated top or other accessories as listed on the schedule.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- E. All dampers shall operate smoothly through their entire range. Provide locking mechanisms to secure volume dampers in position. Mark all damper axles permanently to indicated damper blade position using a file, scratch awl or similar tool.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire and smoke dampers according to UL listing.

- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Downstream from manual volume dampers, control dampers, turning vanes, and equipment.
  - 3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 4. At each change in direction and at maximum 50-foot spacing.
  - 5. Upstream of turning vanes.
  - 6. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. **Access Door Sizes:**
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: 25 by 14 inches.
  - 6. Body plus Ladder Access: 25 by 17 inches.
  - 7. At splitter dampers (use 8" X 8" door).
  - 8. At volume dampers (use 8" X 8" door).
  - 9. At fire dampers (use largest standard square size duct will accept).
  - 10. At motorized dampers (use largest standard square size duct will accept or multiple 12" X 12" size to provide service access to the entire damper).
  - 11. At duct coils (use largest standard square size duct will accept or multiple 12" X 12" size to provide service access to the entire coil. Access shall be provided at both sides of the coil to facilitate cleaning of coil). Immediately downstream of all duct-mounted humidifiers (Use largest standard square size duct will accept or multiple 12" X 12" size to provide service access to the entire coil. Access shall be provided at both sides of the coil to facilitate cleaning of coil) to provide access to entire humidifier grid.

- L. Label access doors to indicate the purpose of access door. If access door is intended for access of mechanical equipment provide the mechanical unit callout number on the access door label.
- M. Install flexible connectors to connect ducts to equipment with at least 4" metal-to-metal. Flexible connections shall be airtight.
- N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- P. Connect diffusers or light troffer boots to low-pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with adhesive draw bands.
- R. Install duct test holes where required for testing and balancing purposes.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- T. Provide air volume extractors or extended, tapered inlet connection where branch ducts are set into the side of trunk ducts as indicated on the plans.
- U. Spin-in connector for round duct connection shall be conical in design unless otherwise noted on plans. Connectors for branch ducts which attach to main duct runs shall be fitted with volume damper.

V. Flexible Ducts

1. Support all flexible ducts with strap hangers in accordance with SMACNA recommendations and mechanical code requirements. Support ducts at an interval not exceeding 4 feet on center and limit sag to less than 1/2" per foot. Support duct to prevent contact with structural members, ceilings and all sources of heat such as lights and piping.
2. Install sheet metal elbows for all bends with a turning radius of less than four feet. All sheet metal elbows, connectors, etc., shall be insulated as specified for sheet metal ductwork.
3. Secure the inner duct liner to sheet metal connectors and fittings with two wraps of sealant tape. Install a stainless-steel draw band over the sealant tape and liner. The liner shall overlap the sheet metal connector by not less than 2".
4. After securing the inner liner, secure the outer insulation jacket with stainless steel or nylon draw bands. Fold the insulation jacket under the draw band so that no fiberglass insulation is exposed.

#### W. Wall and Floor Penetrations

1. Provide sheet metal sleeves in all concrete or masonry walls and floors. Frame or sleeve openings through stud walls.
2. Sleeves and openings sized to accept the duct with insulation. Pack insulation in after duct is installed.
3. Grout sleeves in place in existing masonry walls or floors.
4. Provide finishing collars on each side of wall or floors at all penetrations.
5. Seal the space between ductwork and sleeves with mildew resistant silicone caulk.

### 3.2 FIELD QUALITY CONTROL

#### A. **Tests and Inspections:**

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

- END OF SECTION -

## SECTION 23 34 23 - HVAC POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. **This Section includes the following:**

1. Centrifugal wall ventilators.
2. Ceiling-mounting ventilators.
3. In-line centrifugal fans.

#### 1.2 SUBMITTALS

- A. **Product Data:** Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
- B. **Shop Drawings:** Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. **NEMA Compliance:** Motors and electrical accessories shall comply with NEMA standards.
- C. **UL Standard:** Power ventilators shall comply with UL 705.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Greenheck.
  2. Loren Cook Company.
  3. Soler and Palau, USA
  4. Or Equal



## 2.2 CENTRIFUGAL WALL VENTILATORS

- A. **Description:** Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- B. **Housing:** Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- C. **Fan Wheel:** Aluminum hub and wheel with backward-inclined blades.
- D. **Belt-Driven Drive Assembly:** Resiliently mounted to housing, with the following features:
  - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
  - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
- E. **Accessories:**
  - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
  - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  - 3. Wall Grille: Ring type for flush mounting.
  - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

## 2.3 CEILING-MOUNTING VENTILATORS

- A. **Description:** Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. **Housing:** Steel, lined with acoustical insulation.
- C. **Fan Wheel:** Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. **Grille:** Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. **Electrical Requirements:** Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. **Accessories:**
  - 1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.

2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Filter: Washable aluminum to fit between fan and grille.
4. Isolation: Rubber-in-shear vibration isolators.
5. Manufacturer's standard roof jack or wall cap and transition fittings.

## 2.4 IN-LINE CENTRIFUGAL FANS

- A. **Description:** In-line, direct -driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. **Housing:** Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. **Direct-Driven Units:** Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- D. **Belt-Driven Units:** Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. **Fan Wheels:** Aluminum, airfoil blades welded to aluminum hub.
- F. **Accessories:**
  1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  2. Companion Flanges: For inlet and outlet duct connections.
  3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

## 2.5 MOTORS

- A. Comply with requirements in Specification Section 23 05 13 Common Motor Requirements for HVAC Equipment.
- B. **Enclosure Type:** Totally enclosed, fan cooled.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install power ventilators level and plumb.

- B. Support units using spring isolators having a static deflection of 1 inch.
  - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- D. **Ceiling Units:** Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch.
- F. Install units with clearances for service and maintenance.
- G. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in specification Section 23 33 00 Air Duct Accessories.
- H. Install ducts adjacent to power ventilators to allow service and maintenance.
- I. Ground equipment according to Division 26 Section
- J. Connect wiring according to Division 26 Section

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that the connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  10. Shut unit down and reconnect automatic temperature-control operators.
  11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- END OF SECTION -

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## **SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

##### **A. Section Includes:**

1. Round ceiling diffusers
2. Rectangular and square ceiling diffusers
3. Perforated diffusers
4. Louver face diffusers
5. Linear bar diffusers
6. Linear slot diffusers
7. Adjustable bar registers, grilles, registers and grilles
8. Fixed face registers, grilles, registers and grilles
9. Linear bar grilles

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Product Data:** For each type of product indicated, include the following:
  1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
  2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- C. **Samples:** For each exposed product and for each color and texture specified.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. **Subject to compliance with requirements, provide products by one of the following or approved Equal:**
  - a. **Carnes**
  - b. **Titus**

c. **Tuttle & Bailey**

d. **Krueger**

## 2.2 CEILING DIFFUSERS

### A. **Round Ceiling Diffuser:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

### B. **Rectangular and Square Ceiling Diffusers:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

### C. **Perforated Diffuser:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

### D. **Louver Face Diffuser:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

## 2.3 REGISTERS AND GRILLES

### A. **Adjustable Bar Register:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

### B. **Adjustable Bar Grille:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

### C. **Fixed Face Register:**

Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

**D. Fixed Face Grille:**

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the manufacturers listed in section 2.1.

**2.4 SOURCE QUALITY CONTROL**

- A. **Verification of Performance:** Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install diffusers, registers, and grilles level and plumb.
- B. **Ceiling-Mounted Outlets and Inlets:** Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

**3.2 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

- END OF SECTION -



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## **SECTION 23 63 13 - AIR COOLED REFRIGERANT CONDENSERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes design, refrigerants, controls, and installation requirements for air-cooled scroll compressor condensing units.

#### **1.2 REFERENCES**

- A. Comply with the applicable Standards and/or Codes of ETL, cETL, NEC, ASHRAE Standard 90.1, and OSHA as adopted by the state.

#### **1.3 SUBMITTALS**

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated, dimensions, required clearances, shipping, installed, and operating weights, furnished specialties, accessories, and installation and startup instructions.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location of each field connection. Detail equipment mounting to supporting structure.
  - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.
- D. All submittals shall be in accordance with specification Section 01 33 00 – Contractor Submittals.

#### **1.4 QUALITY ASSURANCE**

- A. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
  - 1. The condensing unit shall be safety certified by ETL and the nameplate shall carry the agency label.

#### **1.5 DELIVERY AND HANDLING**

- A. Condensing unit shall be delivered to the jobsite with factory holding charge and be factory charged with oil by the manufacturer.
- B. Comply with the manufacturer's instructions for rigging and handling equipment.

## 1.6 WARRANTY

- A. The refrigeration equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 18 months from date of original equipment shipment from the factory. The warranty shall cover material and workmanship that prove defective within the above period, excluding refrigerant.
- B. **Options:**
  - 1. Compressors shall carry a 5 year warranty from date of original equipment shipment from the factory.

## PART 2 - PRODUCTS

### 2.1 CONDENSING UNITS

- A. **Unit Description:** Provide and install as shown on the plans, factory assembled, air-cooled scroll compressor condensing units in the quantity specified. Each unit shall consist of an air-cooled condenser section with hermetic scroll compressor and isolated control compartment containing: control system, suction and liquid connection valves, and all components necessary for safe and controlled unit operation when connected to the specified low side equipment.
- B. **Construction:**
  - 1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.
  - 2. Unit shall be specifically designed for outdoor application.
  - 3. The condenser coil shall be mechanically protected from physical damage by painted galvanized steel louvers covering the full area of the coil.
  - 4. Options (Multiple selections are permissible):
    - a. Paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117-95 test procedure.
    - b. The condenser coil shall be mechanically protected from physical damage by a wire guard covering the full area of the coil.

### 2.2 DESIGN REQUIREMENTS

- A. **General:** Provide a complete scroll compressor condensing unit as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in this specification and any local codes in effect.
- B. **Performance:** Refer to the schedule of performance on the unit rating page. The unit shall be capable of stable cooling operation to a minimum of 32°F outdoor temperature.

## 2.3 CONDENSING UNIT FEATURES

### A. Compressor:

1. The compressor shall be two step, single circuited, sealed hermetic scroll type, with inherent thermal overload protection and shall be mounted on rubber vibration isolators.
2. Each compressor shall be furnished with a crankcase heater.
3. Options:
  - a. The compressor shall be covered by a high-density foam sound attenuating blanket to reduce radiated noise.

### B. Condenser:

1. The condenser coil shall consist of seamless copper tubes mechanically bonded into plate type aluminum fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling section shall be an integral part of the main condenser coil.
2. The condenser fan shall be propeller type arranged for vertical air discharge and driven by a direct drive fan motor. The fan discharge area shall be equipped with a heavy-gauge fan guard.
3. Fan motor shall be weather protected, single phase, direct drive, ECM 2.3 motor.
4. Options:
  - a. Coil shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mils on all surface areas including fin edges. Superior hardness characteristics of 2H per ASTM D3363-92A and a cross-hatch adhesion of 4B-5B per ASTM B3359-93. Impact resistance shall be up to 160 in/lb per ASTM D2794-93. Humidity and water immersion resistance shall be up to a minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 6000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of e-coat.
  - b. Coil shall be copper tubes with copper fins mechanically bonded to the tubes.

### C. Refrigerant Circuit:

1. The condensing unit shall operate with R-410A refrigerant. The condensing unit shall be furnished with a liquid line filter drier and service valves for liquid and suction connections. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, insulated hot gas bypass line, insulated hot gas line, and insulated suction line.

2. Options:

- a. External hot gas bypass shall be provided on the refrigerant circuit.
- b. Condensing unit shall be provided with adjustable condenser head pressure control to allow cooling operation down to 35°F.
- c. Unit shall dehumidify using modulating hot gas reheat control valves, an electronic controller, and a matching air handler that includes a hot gas reheat coil. Field installed liquid line receiver tank shall be factory provided.

**D. Control System:**

1. A centrally located weatherproof control panel shall be isolated from condenser coil airflow, and shall contain the field power connection points, control terminal block and control system.
2. Power and starting components shall include fan motor contactors, 5 minute off time delay relays for the compressor, inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Safety and operating controls shall include a manually reset high pressure switch and an automatic reset low pressure switch. Barrier panels shall be furnished to protect against accidental contact with line voltage when accessing the control system.
3. Option:
  - a. Control circuit transformer and wiring shall provide 24V control voltage from the line voltage provided to the unit.

**E. Wiring Diagrams:**

1. Color-coded and marked wiring diagrams shall be provided to match the color and markings of the unit wiring.
2. Diagrams shall be laminated in plastic and permanently fixed to the control compartment door.
3. Installation, Operation, and Maintenance manual shall be supplied with unit within the control compartment.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install in strict accordance with manufacturer's requirements, shop drawings, and contract documents.
- B. Adjust and level unit on supports.
- C. Install refrigerant piping in accordance with drawings.

- D. Evacuate the system and charge with refrigerant in accordance with standard practice.
- E. Coordinate electrical installation with electrical contractor.
- F. Coordinate controls with control contractor.
- G. Provide all appurtenances required to insure a fully operation and functionally system.

### 3.2 STARTUP

- A. Check and assure proper system charge of refrigerant and oil.
- B. Provided testing, and starting of system, and instruct the Owner in its proper operation and maintenance.

- END OF SECTION -

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## SECTION 23 82 39 - UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. **Section Includes:**

1. Cabinet unit heaters with centrifugal fans and electric coils.
2. Propeller unit heaters with hot-water and electric coils.
3. Electric resistance wall heaters

#### 1.2 SUBMITTALS

- A. **Product Data:** Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. **Shop Drawings:** Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  1. Plans, elevations, sections, and details.
  2. Location and size of each field connection.
  3. Equipment schedules to include rated capacities, furnished specialties, and accessories.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

#### 1.3 QUALITY ASSURANCE

- A. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### PART 2 - PRODUCTS

#### 2.1 CABINET UNIT HEATERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  1. Qmark
  2. Trane.
  3. Indeeco.



4. TPI
  5. Or Approved Equal
- B. **Description:** A factory-assembled and -tested unit complying with ARI 440.
1. Comply with UL 2021.
- C. **Cabinet:** Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch- thick, galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch- thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  3. Recessing Flanges: Steel, finished to match cabinet.
  4. Control Access Door: Key operated.
  5. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware
- D. **Fan and Motor Board:** Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
  2. Motor: Permanently lubricated multispeed; resiliently mounted on motor board. Comply with requirements in specification Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
  3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- E. Control devices and operational sequences are specified in Section 23 09 00 – Instrumentation and Control for HVAC.
- F. **Basic Unit Controls:**
1. Scheduled Operation: Thermostat with Occupied and unoccupied modes on seven-day clock with a minimum of four programmable periods per day.
  2. Unit Supply-Air Fan Operations:
    - a. Occupied Periods: Fan runs continuously.

- b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
- G. **Electrical Connection:** Factory wire motors and controls for a single field connection.

H. **Capacities and Characteristics:**

- 1. Cabinet:
  - a. Vertical, Semirecessed: Upflow.
    - 1) Air Inlet: Front, punched louver grille.
    - 2) Air Outlet: Front

2.2 WALL AND CEILING HEATERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Berko Electric Heating
  - 2. Chromalox, Inc.
  - 3. TPI Corporation.
  - 4. Marley Electric Heating.
  - 5. QMark Electric Heating
  - 6. Trane.
  - 7. Or Approved Equal
- B. **Description:** An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- C. **Cabinet:**
  - 1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
  - 2. Finish: Baked enamel over baked-on primer with manufacturer's standard color, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- D. **Surface-Mounting Cabinet Enclosure:** Steel with finish to match cabinet.
- E. **Electric-Resistance Heating Coil:** Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

- F. **Fan:** Aluminum propeller directly connected to motor.
  - 1. Motor: Permanently lubricated, multispeed. Comply with requirements in specification Section 23 05 13 – Common Motors Requirements for HVAC Equipment.
- G. **Controls:** Unit-mounted thermostat.
- H. **Electrical Connection:** Factory wire motors and controls for a single field connection.

## 2.3 DOWNFLOW CEILING MOUNTED HEATERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Berko Electric Heating.
  - 2. Chromalox, Inc.
  - 3. TPI Corporation.
  - 4. Marley Electric Heating.
  - 5. QMark Electric Heating.
  - 6. Trane.
  - 7. Or Approved Equal
- B. **Description:** An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- C. **ELEMENTS:** Elements shall consist of Nickel Chromium alloy resistance wire embedded and completely surrounded in Magnesium Oxide, enclosed and swagged into corrosion resistant sheaths. Corrosion resistant steel fins shall be permanently attached to the sheaths to provide maximum heat transfer to the air stream.
- D. **MOTORS:** Motors shall be single phase, resilient mounted, totally enclosed, industrial rated with an automatic reset thermal overload protective device. Motors on heaters up to 20 KW capacity shall be permanently lubricated shaded pole type. Over 20 KW, motors shall be permanent split capacitor type. Motors shall be mounted out of the main air stream in such a manner as to allow ambient air to be drawn over the motor to reduce motor temperature. Motor shall be separately removable from beneath the heater without removing the entire heater from mounting bracket.
- E. **FAN BLADES:** Fan blades shall be heavy-duty individually balanced axial flow type. Fan speed shall not exceed 1570 RPM.

- F. **THERMAL OVERLOAD PROTECTION:** All heaters shall be equipped with a manual reset thermal cutout which disconnects elements and motor in the event normal operating temperatures are exceeded.
- G. **WIRING:** Heaters shall be designed for a single supply circuit with elements, motor and control circuits subdivided and fused to conform with the latest National Electric Code and OSHA requirements. All three phase heaters shall have balanced phases.
- E. **CONTROLS:** Heaters shall be controlled by a low voltage wall mounted thermostat. All heaters 25 KW and larger shall be wired for 2 stage operation. 5 KW through 20 KW units are single stage. All heaters shall be equipped with a fan safety device that causes fan to operate after elements are de-energized to purge unit of residual heat.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install heaters to comply with NFPA 90A.
- B. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in specification Section 22 - Vibration and Seismic Controls.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in specification Section 22 05 48 - Vibration and Seismic Controls. Vibration hangers are specified in specification Section 22 05 48 - Vibration and Seismic Controls.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Install new filters in each unit within two weeks of Substantial Completion.
- F. Comply with safety requirements in UL 1995.
- G. Ground equipment and connect wiring in accordance with specification 26 05 83 Wire & Cable.

### **3.2 FIELD QUALITY CONTROL**

- A. **Perform the following field tests and inspections and prepare test reports:**
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

- END OF SECTION -

## **SECTION 23 83 00 - Electric Radiant Heaters**

### **Part 1 - PART 1 – GENERAL**

#### **1.1 SUMMARY**

- A. This section includes electric radiant heaters used for heating applications.
- B. The CONTRACTOR shall provide the electric heaters, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.
- C. Where 2 or more heaters or appurtenances of the same type or size are required, they shall be furnished by the same manufacturer

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

- A. National Electrical Code
- B. NFPA 70
- C. Canadian Electrical Code, Part 1, C22.1

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Submittals shall be furnished in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Show mounting methods and reflector details.
- C. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

#### **1.4 QUALITY**

- A. Codes and Permits
  - 1. The WORK shall be in strict accordance with the California State Mechanical Code, the State of California building code, local codes and any other authorities having jurisdiction.
  - 2. The CONTRACTOR shall have the required certification and be thoroughly familiar with the local codes.
  - 3. The CONTRACTOR shall obtain and pay for necessary permits.
- B. Diligent Care
  - 1. Care shall be taken at all times to protect floors, stairways, and walls during the make-up, erection of piping and placing of equipment.
  - 2. The CONTRACTOR shall remove all stains and repair all damage before final acceptance of the WORK.

### C. Materials

1. The materials used in connection with the electric heating system work shall:
  - .1 be new;
  - .2 be free from flaws and defects;
  - .3 be fully equal to the quality specified; and,
  - .4 conform to the requirements of applicable specifications and standards.
2. If during the construction of the Project the ENGINEER finds materials that have identifying marks removed, or lacking such marks completely, such items may be rejected until the CONTRACTOR has shown proof that said items conform to the indicated requirements, where the adequacy and extent of such proof shall be determined by the ENGINEER.

### 1.5 WARRANTY

- A. The electric radiant heater equipment manufacturer's warranty shall be for a period of one year from date of equipment start up but not more than 18 months from date of original equipment shipment from the factory. The warranty shall cover material and workmanship that prove defective within the above period.

### 1.6 GENERAL

- A. Motors shall be in conformance with the requirements of Section 26 05 10 Low-Voltage AC Electric Motors.
- B. The electrical system and components for electric heating systems shall be in conformance with the requirements of Section 23 05 00 HVAC General.

### 1.7 ELECTRIC RADIANT HEATERS

- A. Provide electric radiant space heaters as indicated.
- B. Heater elements shall be:
  1. single-ended;
  2. 0.475-inch diameter;
  3. alloy-sheathed;
  4. UL-listed for indoor and outdoor applications;
  5. of moisture-resistant construction such that the entire assembly can be hosed down to remove dust and dirt;
  6. provided with a polished aluminum reflector housing; and, of lightweight construction.

C. The heaters shall be rated at as noted on the drawings.

D. Electric Radiant Heaters Manufacturers, or Equal

1. Chromalox
2. TPI
3. Indeeco
4. SRP

E. Type 1: Ceiling mount type

1. High density radiant panel heater designed for ceiling mounted or roof structure suspended installation.
2. Plaster frame for flush installation in gypsum board ceilings where required.
3. Unit constructed of min 24 ga corrosion resistant steel with radiant surface finished on high emissivity textured latex acrylic paint. Assembly to incorporate insulation mass on back of heating element.

## 1.8 CONTROLS

A. Thermostat and solid state

## Part 2 - EXECUTION

### 2.1 INSTALLATION

- A. Install infrared heaters and controls as indicated and in accordance with manufacturer's instructions.
- B. Ensure that manufacturer's mounting instructions for each fixture, including minimum distances from ceiling, walls, or combustible materials, are followed.
- C. Make power and control connections.

### 2.2 COMMISSIONING

- A. With all circuits connected and prior to waterproofing and sealing, perform resistance tests on each circuit with an ohmmeter. Measured resistance must equal calculated resistance using the following formula:

$$\text{Resistance (ohms)} = \frac{(\text{Design voltage})^2}{\text{Total Wattage}}$$



- B. Recheck all connections and re-do as necessary until measured resistance is equal to calculated resistance.
- C. Waterproof and seal all connections according to manufacturer's instructions.
- D. Recheck resistance measurements to ensure resistance is the same as previously measured.
- E. Notify ENGINEER immediately if any discrepancy is found.
- F. Check and confirm satisfactory operation of radiant heating system.

### 2.3 QUALIFIED INSTALLER

- A. The entire installation, wiring and testing shall be done by a trained installer.

- END OF SECTION -

## **SECTION 26 00 00 - BASIC ELECTRICAL REQUIREMENTS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide electrical WORK, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section apply to all sections in Division 26, except as indicated otherwise.
- C. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various sections of Division 26 is included as a part of the WORK under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

#### **1.2 RELATED SECTIONS**

- A. The WORK of this Section is required for operation of electrically-driven equipment provided under specifications in other Divisions. The CONTRACTOR'S attention is direction to the requirement for proper coordination of the WORK of this Section with the WORK of HVAC, process and instrumentation control, and other equipment sections, including, but not limited to the following:
  - 1. Section 23 05 00 – Heating, Ventilation, and Air Conditioning, General
  - 2. Section 35 79 13 – Traveling Belt Intake Screen
  - 3. Section 40 90 00 – Process Instrumentation and Control, General
  - 4. Section 40 90 05 – Control Enclosures and Devices
  - 5. Section 40 90 10 – Instrumentation for Process Systems
  - 6. Section 40 90 18 – Vendor Package Control Systems
  - 7. Section 44 35 04 – Packaged Booster Pump System
  - 8. Section 44 35 35 – Horizontal End Suction Centrifugal Pumps
  - 9. Section 44 35 56 – Submersible Sump Pumps

#### **1.3 REFERENCE STANDARDS**

- A. The following apply to all sections in Division 26, except as indicated otherwise:

**California Air Resources Board (CARB)**

**California Code of Regulations (CCOR)**

Title 24 – California Building Standards Code

## **California Public Utilities Commission (CPUC)**

General Order No. 128 – Construction of Underground Electric  
Supply and Communication Systems

## **National Electrical Contractors Association (NECA)**

National Electrical Installation Standards

## **National Electrical Manufacturers Association (NEMA)**

250 Enclosure for Electrical Equipment (1000 Volts Maximum)

Z535.4 Product Safety Signs and Labels

## **International Electrical Testing Association (NETA)**

## **National Fire Protection Association (NFPA)**

70 National Electrical Code (NEC)

- B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.
- D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

### **1.4 SIGNAGE AND MARKINGS**

- A. **Identification:** Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal and state OSHA and NEC requirements.
- B. Each local disconnect switch for motors and equipment shall be legibly marked to indicate its purpose unless the purpose is indicated by the location and arrangement.

### **1.5 PERMITS AND INSPECTION**

- A. Permits shall be obtained and inspection fees shall be paid according to the General Conditions.

### **1.6 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals and with the specific requirements of each section in Division 26.
- B. Only submit catalog cutsheets relevant to the WORK. Entire catalogs and catalog sections submitted that contain a small percentage of equipment relevant to the WORK will be rejected.
- C. **General Submittal Requirements:** Provide the following:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Front, side, rear elevations, and top views with dimensional data.
3. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
4. Method of anchoring, seismic requirements, weight.
5. Types of materials and finish.
6. Nameplates.
7. Temperature limitations, as applicable.
8. Voltage requirement, phase, and current, as applicable.
9. Front and rear access requirements.
10. Grounding requirements.
11. Catalog cuts of bulletins or brochures for applicable standard equipment. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options.

D. **Technical Manuals:** Complete information in accordance with Section 01 33 00 – Contractor Submittals.

#### 1.7 AREA DESIGNATIONS

- A. Electric WORK specifically indicated in sections within any of the specifications shall comply with the requirements of those sections unless indicated otherwise.
- B. CONTRACTOR shall avoid installing electrical equipment in the vicinity of equipment or structures known to routinely splash or spray water, such as fish raceways. Where electrical equipment could be subject to such conditions, coordinate with OWNER to determine alternate locations and conduit routing paths. If installing electrical equipment in such areas cannot be avoided, as determined by OWNER, CONTRACTOR will provide NEMA 4 or better enclosures, and raceway and equipment suitable for such areas.
- C. **The following areas are designated as wet areas:**
  1. Outdoor areas.
  2. Below-grade areas, such as vaults and handholes.
- D. **The following areas are designated as wet areas with splashing or spraying water:**
  1. Coho Building: 72" above finished floor and below.
  2. Chinook Incubation Building: 72" above finished floor and below.

3. Spawning Building: 72" above finished floor and below.

**E. The following areas are designated as dry areas:**

1. Chinook Incubation Building Electrical Room.

F. Areas not mentioned above are designated as general industrial areas.

**1.8 ENCLOSURES**

A. Above-grade raceway system enclosures shall be provided in accordance with Section 26 05 33 – Electrical Raceway Systems.

B. Below-grade raceway system enclosures shall be provided in accordance with Section 26 05 43 – Underground Raceway Systems.

C. Provide the following NEMA 250 enclosure types for electrical equipment, unless indicated otherwise:

1. **Wet Areas:** NEMA 3R.

2. **Wet Areas with Splashing or Spraying Water:** NEMA 4.

3. **Dry Areas:** NEMA 1.

4. **General Industrial Areas:** NEMA 12.

**D. Material Requirements:**

1. NEMA 1, 3R, 4, and 12 enclosures shall be steel, primed and coated with ANSI 61 light grey paint.

**1.9 QUALITY ASSURANCE**

A. Short circuit and arc flash studies shall be prepared by a Professional Electrical Engineer registered in the State of California.

**1.10 ELECTRICAL STUDY SEQUENCING AND SCHEDULING**

A. Initial short circuit study shall be submitted and accepted before OWNER'S REPRESENTATIVE will review submittals on electrical distribution equipment.

B. Revised short circuit and arc flash studies, and arc flash labels shall be submitted and accepted prior to energizing electrical equipment.

C. Final short circuit and arc flash studies shall be submitted and accepted prior to Substantial Completion. Final version of studies shall include as-installed equipment and materials.

D. Submit final arc flash labels as described herein prior to Substantial Completion.

## 1.11 TESTS

- A. Perform in accordance with 26 01 26 – Electrical Testing.
- B. The CONTRACTOR shall be responsible for factory and field tests required by specifications in Division 26 and by the OWNER'S REPRESENTATIVE or other authorities having jurisdiction. The CONTRACTOR shall furnish necessary testing equipment and pay costs of tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.
- C. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the Shop Drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.
- D. Equipment or material that fails a test shall be removed and replaced or, if the OWNER'S REPRESENTATIVE approves, may be repaired and retested for compliance. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be done in a manner that does not void the warranty.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Equipment and materials shall be new, shall be listed by UL, and shall bear the UL label where UL requirements apply.
- B. Equipment and materials shall be the products of experienced and reputable manufacturers in the industry.
- C. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- D. Equipment and materials shall be of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, the CONTRACTOR shall utilize that type of enclosure, even though certain modifications such as cutouts for control devices may negate the NEMA rating.

### 2.2 MOUNTING HARDWARE

- A. **Nuts, Bolts, and Washers:** Provide in accordance with Section 05 50 00 – Miscellaneous Metalwork.
- B. **Threaded Rods for Trapeze Supports:** Provide in accordance with Section 05 50 00 – Miscellaneous Metalwork.
- C. **Anchors for Attaching Equipment to Concrete Walls, Floors, and Ceilings:** Provide in accordance with Section 05 50 00 – Miscellaneous Metalwork.
- D. **Framing Channel:**

1. Types:
  - a. Carbon steel, with hot-dip galvanization.
  - b. Carbon steel, with electro-deposited, rust-inhibiting paint coating.
2. Steel framing channel shall be 12-gauge minimum.
3. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion.
4. Manufacturers, or equal:
  - a. **Unistrut.**
  - b. **B-Line.**
  - c. **Power-Strut.**

## 2.3 ARC FLASH WARNING LABELS

- A. Provide arc flash warning labels printed in color on thermally-bonded, adhesive-backed, UV- and weather-resistant labels, and in compliance with NEMA Z35.4.

## 2.4 ELECTRICAL IDENTIFICATION

- A. **Nameplates:** Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock, **Formica Type ES-1** or equal. Each shall be fastened securely, using fasteners of stainless steel screwed into inserts or tapped holes as required. Engraved characters shall be block style with no characters smaller than 1/8-inch top to bottom. Adhesive material shall not be the only form of attaching nameplates.
- B. **Conductor and Equipment Identification:** In accordance with Section 26 05 83 – Wire & Cable.

# PART 3 -- EXECUTION

## 3.1 GENERAL

- A. **Incidentals:** The CONTRACTOR shall provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.
- B. Raceway routing shall be in accordance with Section 26 05 33 – Electrical Raceway Systems.
- C. **Field Control of Location and Arrangement:** The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined by the CONTRACTOR in the field based on the

physical size and arrangement of equipment, finished elevations, and other obstructions. Locations on the Drawings, however, shall be followed as closely as possible.

1. Equipment shall be installed in such a manner as to avoid obstructions, to preserve headroom, and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located as indicated. If equipment is installed without instruction and must be moved, it shall be moved without additional cost to the OWNER. Lighting fixture locations shall be adjusted slightly to avoid obstructions and to minimize shadows.
  2. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- D. **Workmanship:** Materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the WORK. Installation shall be coordinated in the field with other trades to avoid interferences.
- E. **Protection of Equipment and Materials:** The CONTRACTOR shall fully protect materials and equipment against damage from any cause. Materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 GENERAL REQUIREMENTS FOR ELECTRICAL STUDIES

- A. Equipment and component tags used in the studies shall be identical to equipment and component tags shown on the Contract Documents.
- B. Perform studies using one of the following software packages, or approved equal:
  1. SKM Power Tools for Windows.
  2. ETAP.
  3. Paladin.
  4. Easy Power.
- C. Utilize proposed load data for studies obtained from Contract Documents and verified by CONTRACTOR for final design.
- D. Make minor modifications to equipment as required to accomplish conformance with short circuit study.
- E. Notify OWNER'S REPRESENTATIVE in writing of required major equipment modifications.



- F. Provide laminated one-line diagrams (minimum 11 inches by 17 inches) to post on interior of doors to rooms where electrical equipment is located. Post diagrams on main distribution panel where electrical equipment is only accessible by hatch and ladder.
- G. Provide arc flash warning labels on equipment as specified in this section.

### 3.3 SHORT CIRCUIT STUDY

- A. Prepare in accordance with IEEE 399.
- B. Prepare separate studies for each unique utility service tap to different sites of the WORK.
- C. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
- D. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
- E. Use cable and bus resistances calculated at 25 degrees C.
- F. Use medium voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation.
- G. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN or XHHW conductors, where specified.
- H. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.
- I. Each study shall include:
  - 1. Calculation methods and assumptions.
  - 2. Typical calculation.
  - 3. Tabulations of calculated quantities.
  - 4. Results, conclusions, and recommendations.
  - 5. Selected base per unit quantities.
  - 6. One-line diagrams.
  - 7. Source impedance data, including electric utility system and motor fault contribution characteristics.
  - 8. Impedance diagrams.
  - 9. Zero-sequence impedance diagrams.
- J. **Three-Phase Bolted Fault:** Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Electric utility's supply termination point.
  2. Service entrance circuit breaker disconnect.
  3. Main distribution panelboard.
  4. Standby generator, or portable generator termination cabinet (where applicable).
  5. Branch circuit panelboard.
- K. **Line-to-Ground Bolted Fault:** Calculate bolted line-to-ground fault current for areas as defined for three-phase bolted fault.
- L. Verify the following for each study:
1. Equipment and protective devices are applied within their ratings.
  2. Adequacy of panelboard bus bars to withstand short circuit stresses.
  3. Adequacy of transformer windings to withstand short circuit stresses.
  4. Cable sizes for ability to withstand short circuit current heating, in addition to normal load currents.
- M. **Tabulations:**
1. General Data:
    - a. Short circuit reactances of rotating machines.
    - b. Cable and conduit material data.
    - c. Bus data.
    - d. Transformer data.
    - e. Circuit resistance and reactance values.
  2. Short Circuit Data:
    - a. Fault impedances.
    - b. X/R ratios.
    - c. Asymmetry factors.
    - d. Motor contributions.
    - e. Short circuit kVA.
    - f. Symmetrical and asymmetrical fault currents.

3. Equipment Evaluation:
  - a. Equipment bus bracing, equipment short circuit rating, transformer, cable.
  - b. Maximum fault current available.

N. Provide a written summary of the following for each study:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

O. Suggest changes and additions to equipment rating and/or characteristics.

P. Notify OWNER'S REPRESENTATIVE in writing of existing circuit protective devices improperly rated for new fault conditions.

Q. Revise data for "as-installed" condition.

### 3.4 ARC FLASH STUDY

A. Perform arc flash hazard study after short circuit study has been completed, reviewed, and accepted.

B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

C. **Base Calculation:** For each major part of the electrical; power system, determine the following:

1. Flash hazard protection boundary.
2. Limited approach boundary.
3. Restricted approach boundary.
4. Incident energy level.
5. Personal Protective Equipment (PPE) required.

D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.

2. Bus voltage.
- E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:
1. Bus name.
  2. Upstream protective device name, type, and settings.
  3. Bus line-to-line voltage.
- F. Produce arc flash evaluation summary sheet listing the following additional items:
1. Bus name.
  2. Upstream protective device name, type, and settings.
  3. Bus line-to-line voltage.
  4. Bus bolted fault.
  5. Protective device bolted fault current.
  6. Arcing fault current.
  7. Protective device trip/delay time.
  8. Breaker opening time.
  9. Solidly grounded column.
  10. Equipment type.
  11. Gap.
  12. Arc flash boundary.
  13. Working distance.
  14. Incident energy.
- G. Analyze short circuit and arc flash calculations and highlight equipment that is determined to be under-rated or causes incident energy values greater than 8 cal/cm<sup>2</sup>. Propose approaches to reduce energy levels.
- H. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:
1. Equipment manufacturer's information used to prepare study.
  2. Assumptions made during study.

3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on thermally-bonded, adhesive-backed UV and weather-resistant labels.

### 3.5 CONCRETE PADS

- A. Provide concrete pads for indoor and outdoor free-standing electrical equipment in accordance with the Contract Documents.
- B. Concrete housekeeping curbs shall be provided for conduit stub-ups in indoor locations that are not concealed by equipment enclosures. Such curbing shall be 3-inches above finished floor or grade.

### 3.6 FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment and raceway.
- B. Framing Channel Type:
  1. Steel Raceway: Galvanized or paint-coated carbon steel channel.
- C. Paint cut ends prior to installation with the following:
  1. Galvanized carbon steel channel: Zinc-rich primer.
  2. Painted carbon steel channel: Rust-inhibiting paint.

### 3.7 EQUIPMENT ANCHORING

- A. Floor-supported and wall- or ceiling-hung equipment and raceway shall be anchored in place by methods that will meet seismic requirements in the area where the project is located and Contract installation requirements.
- B. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract. Such recommendations shall be submitted as Shop Drawings under Section 01 33 00 – Contractor Submittals.

### 3.8 EQUIPMENT IDENTIFICATION

- A. Nameplates shall be provided for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.
- B. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.

- C. Toggle switches that control loads out of sight of switches and multi-switch locations of more than 2 switches shall have suitable labeled finish plates.
- D. Equipment names and tag numbers, where indicated on the Drawings, shall be utilized on nameplates.
- E. The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the outlets connected to each circuit.
- F. Termination points on terminal blocks shall be labeled by identifiers on the blocks. Identifiers shall be preprinted by the terminal manufacturer or custom-printed. Hand lettered markers will not be acceptable.
- G. Distribution equipment, stand-alone disconnects, starters, and VFDs shall be tagged with appropriate arc-flash labels.

### 3.9 CLEANING

- A. Before final acceptance, the electrical WORK shall be thoroughly cleaned to the OWNER'S satisfaction:
  - 1. Exposed parts shall be thoroughly cleaned of cement, plaster, and other materials.
  - 2. Temporary tags, markers, stickers, etc. shall be removed.
  - 3. Oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped, and cracks and corners scraped out.
  - 4. Touch-up paint shall be applied to scratches on panels and cabinets.
  - 5. Electrical cabinets or enclosures shall be vacuumed.
  - 6. Light fixtures shall be cleaned inside and out.
- B. Debris and refuse from cleaning shall be disposed of off the Site.

- END OF SECTION -

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## SECTION 26 01 00 - BASIC ELECTRICAL MATERIALS AND METHODS

### PART 1 -- GENERAL

#### 1.1 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **National Electrical Manufacturers Association (NEMA)**

AB 1	Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
KS 1	Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
WD 1	General Color Requirements for Wiring Devices
WD 6	Wiring Devices – Dimensional Specifications

##### **Underwriters Laboratories, Inc. (UL)**

98	Enclosed and Dead-Front Switches
467	Grounding and Bonding Equipment
486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
486F	Bare and Covered Ferrules
489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
498	Standard for Attachment Plugs and Receptacles
1059	Standard for Terminal Blocks

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

**B. Product Data:**

1. Circuit Breakers:
  - a. Enclosures.
  - b. Time-current curves for breaker frames larger than 125A.
  - c. Electronic trip unit data, where applicable.
  - d. Accessories.
  - e. Wiring diagrams for accessories, such as shunt trip coils.



2. Non-fused safety switches.
3. Intrusion switches.
4. Wiring devices.
5. Device plates.
6. Grounding connectors.
7. Ground rods.

## **PART 2 -- PRODUCTS**

### **2.1 MOLDED-CASE CIRCUIT BREAKER, LOW VOLTAGE**

- A. Molded-case circuit breakers shall be manufactured in accordance with NEMA AB 1 and UL 489.
- B. Trip ratings as shown on Drawings.
- C. Voltages: 120, 240, 277, 480, and 600 volts ac, as indicated.
- D. Provide 100% rated circuit breakers where shown. Otherwise, provide 80% rated circuit breakers.
- E. Where indicated, provide circuit breakers and accessories labeled for use as a service entrance.
- F. **Operating Mechanism:**
  1. Toggle-type operating handle, with quick-make and quick-break action.
  2. Locking provisions for padlocking in the OPEN position.
  3. ON, OFF, and TRIPPED indicating positions of operating handle.
- G. **Trip Mechanism, Thermal Magnetic Type:**
  1. Individual thermal and magnetic trip elements in each pole.
  2. Adjustable, continuous magnetic trip elements with adjustment range of 3- to 10-times rated current for frames greater than 125A.
  3. Two- and three-pole breakers shall be common trip.
  4. Mechanism opens all poles when overcurrent occurs on any single pole.
  5. Test button on cover.
  6. Using single-pole circuit breakers with handle ties to make multi-pole circuit breakers will not be acceptable.

**H. Solid State (Electronic) Trip Type:**

1. Provide electronic trip circuit breaker where indicated on Drawings with some combination or all of the letters 'L', 'S', 'I', and 'G'. These letters indicate required trip unit functions, as defined below.
2. Electronic trip units shall be UL listed.
3. Includes current sensors and logic circuits integral to breaker frame.
4. True rms sensing, with LED long-time pickup and trip indication.
5. Where indicated, equipped with the following adjustable settings:
  - a. 'L': Long-time pickup and time delay.
  - b. 'S': Short-time pickup and time delay.
  - c. 'I': Instantaneous pickup.
  - d. 'G': Ground fault trip and time delay.
6. Trip button on front cover of breaker to permit manual tripping of breaker.
7. Cause-of-trip troubleshooting function, via LEDs or LCD display.

**I. Short Circuit Interrupting Ratings:**

1. Not less than the following rms symmetrical currents for the indicated trip ratings or as shown on the Contract Drawings:
  - a. 250 volts ac and less, 100A and less: 10 kA.
  - b. 250 to 600 volts ac, 100A and less: 14 kA.
  - c. More than 100A: 18 kA.

**J. Accessories:**

1. Provide interlocks, handle locks, double lugs, and mounting bases as shown or as required.

**K. Connections:**

1. Capable of line side conductors landing at either end.
2. Mechanical lugs, except crimp compression lugs where shown.
3. Removable/replaceable lugs for frames rated more than 100A.
4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.

**L. Independent Enclosures for Circuit Breaker Mounting:**

1. Enclosure: NEMA 250, type as indicated in Section 26 00 00 – Basic Electrical Requirements.
2. Service Entrances: Where indicated, provide circuit breakers and accessories in enclosures labeled for use as a service entrance.
3. Interlock: Enclosure and breaker handle shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

**2.2 INTRUSION SWITCHES**

- A. Rugged industrial switches designed for magnetic intrusion detection on entry doors and overhead doors.
- B. Switches shall be UL listed.
- C. Switches shall be gray and have concealed screw terminals.
- D. Voltage: 24 Vdc.
- E. Configuration: One SPDT (form C) contact.
- F. Gap Distance: Up to 1-1/4 inches.
- G. Manufacturer and Model, or Equal:
  1. **GE Security; 1047TN.**

**2.3 WIRING DEVICES**

- A. Devices shall be manufactured in accordance with NEMA WD 1 and WD 6, and UL 498.
- B. **Color:** Gray.
- C. **Lighting Switches:**
  1. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
  2. Rivetless one-piece brass or copper alloy contact arm with silver alloy contacts.
  3. Rating: 20 amps, 120/277 volts.
  4. Automatic grounding clip and integral grounding terminal on mounting strap.
  5. Single Pole Manufacturer and Model, or Equal:
    - a. **Bryant; 4901.**
    - b. **Hubbell; HBL1221.**

c. **Leviton; 1221 series.**

**D. Receptacles, General Purpose:**

1. Industrial grade, duplex, two-pole, three-wire grounding type with screw terminals.
2. Impact-resistant nylon body, with finger grooves in face.
3. Rivetless one-piece construction.
4. Rating: 5-20R, 20 amps, 125 volts.
5. Integral ground contact on mounting strap.
6. Sized for 2-inch by 4-inch outlet box.
7. Manufacturers, or Equal:
  - a. **Cooper; 5362 series.**
  - b. **Hubbell Bryant; HBL5362 series.**
  - c. **Leviton; 5362 series.**

**E. Receptacle, Ground Fault Circuit Interrupter (GFCI):**

1. Meet requirements of Receptacle, General Purpose subparagraph.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Listed weather-resistant per NFPA 70, Article 406.8.
4. Feed-Through Capability: 20 amps.
5. Manufacturers, or Equal:
  - a. **Cooper; WRVGF20 series.**
  - b. **Hubbell Bryant; GFTR20 series.**
  - c. **Leviton; 7899 series.**

**F. Device Boxes:**

1. In accordance with Section 26 05 33 – Electrical Raceway Systems, unless noted otherwise.
2. Surface-mounted switches and receptacles:
  - a. Dry Areas: Sheet steel boxes.
  - b. Outdoor and Indoor Wet or Damp Areas: Cast metal device boxes.

**G. Device Plates and Covers:**

1. Sectional type plate not permitted.
2. Stainless steel screws and hardware, unless noted otherwise.
3. Sheet Steel:
  - a. For use only on sheet steel device boxes.
  - b. Zinc electroplate finish.
4. Cast Metal:
  - a. For use only on cast metal devices boxes, unless noted otherwise.
  - b. Same material as box, weatherproof, with gaskets.
5. Weatherproof:
  - a. Receptacle, Weatherproof While in Use:
    - 1) UL listed for wet locations while in use.
    - 2) Die cast metal cover.
    - 3) Manufacturer, or Equal:
      - a) **TayMac.**
      - b) **Red Dot.**
  - b. Receptacle, Weatherproof While Closed:
    - 1) UL listed for wet locations while closed and for damp locations open or closed.
    - 2) Gasketed cast aluminum with self-closing individual caps over each receptacle opening.
    - 3) Manufacturer, or Equal:
      - a) **Crouse-Hinds.**
      - b) **Appleton.**
  - c. Lighting Switch, Weatherproof Toggle:
    - 1) Gasketed cast metal, with external operator for switch.
    - 2) Manufacturer, or Equal:

- a) **Crouse-Hinds.**
  - b) **Appleton.**
- d. Lighting Switch, Weatherproof Dimmer:
  - 1) Gasketed cast metal, with self-closing cap or hood over opening.
  - 2) Cap or hood shall be sufficiently deep to house dimmer switch controls without negating the weatherproof listing.
  - 3) Manufacturer, or Equal:
    - a) **Crouse-Hinds.**
    - b) **Appleton.**

#### 2.4 NONFUSED SWITCH, INDIVIDUAL, 600 VOLTS

- A. Components shall be manufactured in accordance with NEMA KS 1 and UL 98.
- B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. **Enclosure:** NEMA 250, type as indicated in Section 26 00 00 – Basic Electrical Requirements.
- E. Enclosure and switch to prevent opening cover with switch in the ON position.

#### 2.5 TERMINAL BLOCKS, 600 VOLTS

- A. Components shall be manufactured in accordance with UL 486F and UL 1059.
- B. Size components to allow insertion of necessary wire sizes.
- C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
- D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
- E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
- F. Yoke shall guide all strands of wire into terminal.
- G. Current bar shall ensure vibration-proof connection.
- H. Terminals:
  - 1. Capable of wire connections without special preparation other than stripping.

2. Capable of jumper installation with no loss of terminal or rail space.
  3. Short-circuiting type for current transformer leads.
- I. Marking system, allowing use of preprinted or field-marked tags.

## 2.6 GROUNDING

- A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 and shall conform to the applicable requirements of NFPA 70, Article 250 and local codes.

**B. Ground Rods:**

1. Copper-clad steel construction.
2. Minimum 3/4-inch diameter and 10-foot length.
3. Sectional-type, joined by threaded copper alloy couplings.

**C. Equipment Grounding Circuit Conductors:**

1. The conductors shall be the same type and insulation as the load circuit conductors.
2. The minimum size shall be as outlined in Table 250.122 of NFPA 70, unless indicated otherwise.
3. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.

**D. Connectors:**

1. Exothermic Weld:
  - a. Outdoor welds shall be suitable for exposure to elements or direct burial.
  - b. Indoor welds shall utilize a low-smoke, low-emission process.
2. Compression:
  - a. Compress-deforming type.
  - b. Wrought copper extrusion material.
  - c. Prefilled with oxide-inhibiting and anti-seizing compound and sealed.
3. Mechanical:
  - a. Split-bolt, saddle, or cone screw type.
  - b. Copper alloy material.

E. Grounding Materials Manufacturer, or Equal:

1. **Erico.**
2. **ThermOweld.**
3. **FCI-Burndy.**

**PART 3 -- EXECUTION**

3.1 GENERAL

- A. Install equipment in accordance with manufacturer's recommendations.
- B. Use appropriate conduit and conductor entry fittings with enclosures to maintain the specified enclosure environmental capability after installation.
- C. Equipment locations, if shown on Drawings, are approximate. Final locations shall be determined in accordance with field conditions and subject to OWNER's approval.

3.2 WIRING DEVICES

- A. Perform WORK in accordance with the requirements of NFPA 70.
- B. Keep boxes free of debris, dust, paint, and other material that may contaminate the raceway system.
- C. **Device Installation:**
  1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  2. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
  3. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  4. Use torque screwdriver when a torque is recommended or required by manufacturer.
  5. Tighten unused terminal screws on device.
- D. **Lighting Switches:**
  1. Box Mounting Height: 48 inches above finished floor or grating or finished grade, unless noted otherwise.
  2. Install on lock side of doors.
  3. Install with switch operation in vertical position.



4. Install single-pole, two-way switches such that toggle is in up position when switch is on.

**E. Receptacles:**

1. Box Mounting Height, unless noted otherwise:
  - a. Indoor Areas: 48 inches above finished floor or grating.
  - b. Outdoor Areas: 24 inches above finished grade.
2. Install with grounding slot up, except where horizontal mounting is shown, in which case install with neutral slot up.
3. Weatherproof Receptacle: Install such that cover hinge or hinges are above openings.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for downstream conventional receptacles.

**F. Grounding:**

1. Devices shall be grounded in accordance with NFPA 70, Article 250, and the provisions in this section.
2. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

**3.3 DEVICE PLATES**

- A. Securely fasten to wiring device; ensure a tight fit to box.
- B. For surface-mounted boxes, plates shall not extend beyond sides of box, unless plates have no sharp corners or edges.
- C. Install with alignment tolerance to box of 1/16-inch.
- D. Do not use oversized or extra deep plates.

**E. Types:**

1. Indoor Dry Areas: Sheet steel.
2. General Industrial Areas: Cast metal.
3. Receptacles, Indoor Wet Areas: Weatherproof while in use.
4. Receptacles, Outdoor Areas: Weatherproof while in use.
5. Switches, Wet Areas: Weatherproof toggle or weatherproof dimmer, as required and as shown.

### 3.4 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Provide a separate grounding conductor for each motor and connect at motor box.
- C. Do not use the motor box bolts or cover as grounding connectors.
- D. Sizes shall be as indicated on the Drawings and in accordance with NEC Article 250.
- E. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.
- F. Individually bond the raceway to the ground bus in the secondary section.
- G. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- H. Provide a separate grounding conductor in each individual raceway for parallel feeders.
- I. **Ground Rods:**
  - 1. Provide ground rods at the indicated locations.
  - 2. Install full length with conductor connection at upper end.
  - 3. Install with connection point below finished grade.
  - 4. Space multiple ground rods by one rod length.
  - 5. Install to 8 feet below local frost depth.
  - 6. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.
  - 7. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.
  - 8. Rods forming an individual ground array shall be equal in length.
- J. **Connections:**
  - 1. Above Grade, Concealed or Exposed: Use compression or mechanical connectors.
  - 2. Above Grade, Embedded or Under-Slab: Use exothermic weld connectors.
  - 3. Below Grade: Use exothermic weld connectors.
  - 4. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

5. The connection shall be made in accordance with the manufacturer's instructions.
6. Notify ENGINEER prior to backfilling ground connections.

**K. Shield Grounding:**

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the Shop Drawings indicate that the shield will be grounded at both ends.
2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.
3. The termination of the shield drain wire shall be on its own terminal screw.
4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

- END OF SECTION -

## SECTION 26 01 26 - ELECTRICAL TESTING

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. This Section specifies the WORK necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.
- B. Field tests shall be performed by a certified test organization, or may be performed by the CONTRACTOR, if specifically approved by the OWNER'S REPRESENTATIVE. Test results shall be submitted to the OWNER'S REPRESENTATIVE for review and acceptance.
- C. Testing Support:
  - 1. The WORK of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications.
  - 2. Electrical testing indicated herein, and functional testing of power and controls not tested under other Sections of Division 26 shall be completed before commencement of the 7-day test of Section 01 75 00 – Startup and Adjustments.
  - 3. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, and the like.
- D. Corrections and Replacements:
  - 1. Before final acceptance, each part of the WORK shall be thoroughly tested, and each test shall be documented.
  - 2. Any materials or equipment failing any test shall be corrected or replaced as required to pass the test at no additional cost to the OWNER.
  - 3. Any materials or equipment failing any test shall be re-tested after correction or replacement to verify compliance.
  - 4. Any failures shall again be corrected or replaced, and then re-tested.
  - 5. The correction/replacement/re-testing cycle shall continue until the item passes the required test(s).

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

#### **Institute of Electrical and Electronics Engineers (IEEE)**

81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1): Normal Measurements

## **National Electrical Manufacturers Association (NEMA)**

AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications

**International Electrical Testing Association (NETA):** Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (ATS)

## **National Fire Protection Association (NFPA)**

70, National Electrical Code (NEC)

70E, Standard for Electrical Safety Requirements for Employee Workplaces

101, Life Safety Code

110, Standard for Emergency and Standby Power Systems

**Occupational Safety and Health Administration (OSHA):** CFR 29, Part 1910, Occupational Safety and Health Standards

### **1.3 CONTRACTOR SUBMITTALS**

#### **A. Technical Manuals:** Include the following:

1. Energization Plan: Prior to initial energization of new electrical equipment, submit the following:
  - a. OWNER'S REPRESENTATIVE's sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
  - b. Staged sequence of initial energization of electrical equipment.
  - c. Lock Out Tag Out (LOTO) plan.
  - d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
2. Submit test or inspection reports and certificates for each electrical item tested within 15 days after completion of test.
3. Operation and Maintenance Data: After test or inspection reports and certificates have been reviewed by OWNER'S REPRESENTATIVE and returned, include a copy of each as part of the electrical Operation and Maintenance Manual.

### **1.4 GENERAL TESTING**

- #### **A.**
- Carry out the tests indicated herein for individual items of materials and equipment in other Sections.

- B. Subsystems shall be defined as individual and collections of pumps, conveyor systems, screen cleaning systems, standby generator systems, and the like.
- C. **Sequencing and Scheduling:**
1. Perform inspection and tests after equipment has been installed.
  2. Perform tests with equipment de-energized whenever feasible.
  3. Inspection and tests on energized equipment shall be scheduled with OWNER and minimized to avoid extended period of interruption to the operating plant equipment.
  4. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.
- D. The following test requirements supplement test and acceptance criteria that may be indicated elsewhere:
1. Demonstrate mechanical and electrical interlocking by attempting to subvert the intended sequence.
  2. Functional Testing:
    - a. A functional test and check of electrical components shall be required prior to performing subsystem testing and commissioning.
    - b. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing.
    - c. Functional testing shall consist of:
      - 1) Inspect for physical damage, proper anchorage and grounding.
      - 2) Check tightness of bolted connections, including conductor terminations of each type of conductors.
      - 3) Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.
      - 4) Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels.
      - 5) Circuit Breakers:
        - a) Circuit breakers 600V and below that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by CONTRACTOR.
        - b) Adjustable time and pickup settings for circuit breakers shall be derived from the system studies performed under Section 26 00 00 – Basic Electrical Requirements.

- c) Settings shall be tabulated and proven for each circuit breaker in its installed position.
- 3. Complete ground testing of grounding electrodes in accordance with the requirements indicated below prior to operating the equipment.
- E. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the OWNER'S REPRESENTATIVE, and after process control devices have been adjusted as accurately as possible.
- F. **Manual and Automatic Mode Demonstration:**
  - 1. After the initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation complies with the indicated requirements.
  - 2. Once the manual mode of operation has been successfully demonstrated, automatic operation shall be demonstrated to verify such items as proper start and stop sequences, proper operation of moving equipment, proper speed control, and the like.
- G. **Ground Resistance Testing:**
  - 1. Provide ground resistance tests on the main grounding electrode or system in the presence of the OWNER'S REPRESENTATIVE and submit results.
  - 2. Utilize the fall-of-potential method or alternative in accordance with IEEE Standard 81.

#### 1.5 COMMISSIONING

- A. Commissioning during the 7-day test as indicated in Section 01 75 00 – Startup and Adjustments shall not be attempted until each subsystem has been found to operate satisfactorily.
- B. Commissioning shall be attempted only as a function of normal plant operation, in which plant process flows and levels are routine, and equipment is operating automatically in response to sensor input parameters or computer command, as applicable.

### PART 2 -- PRODUCTS – Not Used

### PART 3 -- EXECUTION

#### 3.1 GENERAL

- A. Perform tests in accordance with requirements of Section 01 75 00 – Startup and Adjustments.
- B. Tests and inspections shall establish:
  - 1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.

2. Installation operates properly.
  3. Equipment is suitable for energization.
  4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective devices, circuit breakers, fuses, power monitoring meters, and other applicable devices in accordance with values established by short circuit and coordination studies as specified in Section 26 00 00 – Basic Electrical Requirements.
- E. Adjust mechanisms and moving parts of equipment for free mechanical movement.
- F. Verify nameplate data for conformance to Contract Documents and approved Submittals.
- G. Realign equipment not properly aligned and correct unlevelness.
- H. Properly anchor electrical equipment found to be inadequately anchored.
- I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screwdriver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
- J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- K. Provide proper lubrication of applicable moving parts.
- L. Inform OWNER'S REPRESENTATIVE of working clearances not in accordance with NFPA 70.
- M. Investigate and repair or replace:
1. Electrical items that fail tests.
  2. Active components not operating in accordance with manufacturer's instructions.
  3. Damaged electrical equipment.
- N. **Electrical Enclosures:**
1. Remove foreign material and moisture from enclosure interior.
  2. Vacuum and wipe clean enclosure interior.
  3. Remove corrosion found on metal surfaces.



4. Repair or replace, as determined by OWNER'S REPRESENTATIVE, door and panel sections having dented surfaces.
  5. Repair or replace, as determined by OWNER'S REPRESENTATIVE, poor fitting doors and panel sections.
  6. Repair or replace improperly operating latching, locking, or interlocking devices.
  7. Replace missing or damaged hardware.
  8. Finish: Provide matching paint and touch up scratches and mars.
- O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals. Revisions from the approved Submittals shall take precedence over the original Contract Documents.

### 3.2 CHECKOUT AND STARTUP

#### A. Voltage Field Test:

1. Check voltage at point of termination of interconnecting power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day. Submit Voltage Field Test Report to OWNER'S REPRESENTATIVE within 7 days of test.
4. Unbalance Corrections:
  - a. Make written request to interconnecting power company to correct condition if balance (as defined by NEMA) exceeds 1.0%, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4.0% of nominal.
  - b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

#### B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after interconnecting power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken. Submit all such reports to OWNER'S REPRESENTATIVE.

### 3.3 WIRE AND CABLES, 600 VOLTS AND BELOW

- A. Inspections and tests shall be performed after installation and prior to placing cable in service.
- B. **Inspect for the following:**
  - 1. For each individual power conductor #6 AWG and larger:
    - a. Physical damage.
    - b. Conformance of connections with Drawings.
    - c. Bends exceeding manufacturer's minimum allowable bending radius.
    - d. Conformance of color coding and identification with Specifications.
  - 2. Mechanical connections for proper lug type, proper lug installation, and bolt torque level in accordance with NETA ATS, Table 100.12.
  - 3. Proper shield grounding, termination, and identification of shielded instrumentation cables.
  - 4. Proper termination and identification of control cables.
  - 5. Proper termination of neutrals and grounds for power cables terminated through window-type CTs.
- C. **Perform the following tests for each individual power conductor #6 AWG and larger:**
  - 1. Insulation Resistance Tests:
    - a. Apply 1,000-volt dc megohmmeter for 600-volt insulated conductors.
    - b. Test each conductor from phase-to-phase and phase-to-ground for one minute.
    - c. Evaluate ohmic values by comparison with conductors of same length and type.
    - d. Investigate values less than 50 megohms.
  - 2. Continuity test by ohmmeter method to ensure proper cable connections.
- D. Control wire and instrumentation cable shall be tested for continuity, polarity, undesirable ground, and origination.
- E. Cables failing the tests shall be replaced with a new cable or repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

### 3.4 DRY-TYPE TRANSFORMERS

#### A. **Inspect for the following:**

1. Damage to the transformer or insulators.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Tap changer is set at correct ratio for rated voltage under normal operating conditions, unless adjusted intentionally as required under the relevant installation specification, or as directed by OWNER'S REPRESENTATIVE.
10. Proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

#### B. **Perform the following tests:**

1. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
    - 1) Winding-to-winding.
    - 2) Winding-to-ground.
  - b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, one minute, and 10 minutes.
  - c. Temperature correct results in accordance with NETA ATS, Table 100.14.
  - d. Temperature corrected insulation resistance values shall be equal to, or greater than, ohmic values established by manufacturer.
  - e. Insulation resistance test results shall be within 1.0% of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

### 3.5 PANELBOARDS

#### A. **Inspect for the following:**

1. Defects and physical damage.
2. Labeling and nameplate compliance with requirements of up-to-date Drawings and panelboard schedules.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

#### B. **Perform the following tests in accordance with manufacturer's instructions:**

1. Exercise and perform operational tests of mechanical components and other operable devices.
2. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
  - b. Each phase of each bus section.
  - c. Phase-to-phase and phase-to-ground for one minute.
  - d. With breakers open and with breakers closed.
  - e. Insulation resistance values shall be equal to, or greater than, ohmic values established by manufacturer.
3. Ground continuity test ground bus to system ground.

### 3.6 INDUCTION MOTORS

#### A. Inspection and testing limited to motors rated 5 hp and larger.

#### B. **Inspect for the following:**

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Proper operation of space heaters and brakes, as applicable.
5. With the motor operating, check for:

- a. Excessive mechanical and electrical noise.
- b. Overheating.
- c. Correct rotation.
- d. Proper operation of vibration detectors, resistance temperature detectors, and other motor-inherent protective devices.
- e. Excessive vibration, in excess of values in NETA ATS Table 100.10.

**C. Perform the following tests:**

- 1. Insulation Resistance Tests:
  - a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.11 for a duration of one minute with resistances tabulated at 30 and 60 seconds.
  - b. Insulation resistance values shall be equal to, or greater than, ohmic values established by manufacturer.
- 2. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
- 3. Measure running current and voltage and evaluate relative to load conditions and nameplate full-load amps.

**3.7 SURGE ARRESTERS**

**A. Inspect for the following:**

- 1. Adequate clearances between arresters and equipment enclosures or buildings.
- 2. Proper ground connections to ground bus.
- 3. Shortest practical jumper connections to line.

**3.8 MOLDED CASE CIRCUIT BREAKERS**

- A. General:** Inspection and testing limited to circuit breakers with frames rated 100A and larger and to motor circuit protectors rated 50A or larger.

**B. Inspect for the following:**

- 1. Proper mounting and cracked casings.
- 2. Proper conductor size.
- 3. Proper operation of switch handle for each enclosed breaker intended for use as a disconnecting means.

4. Conformance of service or feeder designation to Contract Documents.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Conformance of frame size and trip setting to Contract Documents.
7. Suitability of terminals for 75 degrees C rated insulated conductors.

**C. Perform the following tests:**

1. Operate breaker to verify smooth operation.
2. Insulation Resistance Tests:
  - a. Applied 1,000-volt dc megohmmeter for 480V breakers in accordance with NETA ATS, Table 100.1.
  - b. Pole-to-pole and pole-to-ground with breaker contacts opened for one minute.
  - c. Pole-to-pole and pole-to-ground with breaker contacts closed for one minute.
  - d. Insulation resistance values shall comply with NETA ATS, Table 100.1.

### 3.9 INSTRUMENT TRANSFORMERS

**A. Inspect for the following:**

1. Cracked insulation, broken leads, defective wiring, proper connections, and adequate clearances between primary and secondary circuit wiring of current, potential, and control transformers.
2. Good contact for grounding and shorting connections.
3. Proper operation of withdrawal mechanism and grounding, where applicable.

**B. Perform the following tests:**

1. Current Transformers:
  - a. Insulation resistance test from winding-to-ground at 1,000 volts dc for 30 seconds.
  - b. Polarity test.
2. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

### 3.10 METERING

**A. Inspect for the following:**

1. Conformance of meter types, scales, and connections with Contract Drawings.

2. Verify meter multipliers.
3. Proper calibration of meters and electrical transducers.

### 3.11 SAFETY SWITCHES, 600 VOLTS AND BELOW

#### A. **Inspect for the following:**

1. Proper blade alignment and operation of switch handle.
2. Proper cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
3. Proper phase barrier material and installation.

#### B. **Perform the following tests:**

1. Mechanical operation test. Verify electrical and mechanical interlocking system operation and sequencing.
2. Insulation Resistance Tests:
  - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
  - b. Phase-to-phase and phase-to-ground for one minute on each pole.
  - c. Insulation resistance values shall be equal to, or greater than, ohmic values established by manufacturer.
3. Perform contact resistance test across each blade.

### 3.12 GROUNDING SYSTEMS

#### A. **Inspect for the following:**

1. Proper connection and tightness of equipment and circuit grounds in motor control centers, panelboards, and switchgear assemblies.
2. Proper termination and tightness of ground bus connections in motor control centers, panelboards, and switchgear assemblies.
3. Effective core and equipment grounding.
4. Proper fit and tightness of accessible connections to grounding electrodes.
5. Inspect accessible exothermic weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

#### B. **Perform the following tests:**

1. Fall-of-Potential Test:

- a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
  - b. Record data and provide to OWNER'S REPRESENTATIVE.
2. Two-Point Direct Method Test:
  - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
  - b. Record data and provide to OWNER'S REPRESENTATIVE.
3. Neutral Bus Isolation:
  - a. Test each neutral bus individually with neutral bonding jumper removed at Service Entrance or separately derived system.
  - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
  - c. Investigate values less than 50 megaohms.
  - d. Record data and provide to OWNER'S REPRESENTATIVE.

### 3.13 MOTOR CONTROL SYSTEMS

#### A. **Inspect for the following:**

1. Inspect for proper operation of indicating and monitoring devices.
2. Inspect for proper overload protection.
3. Check for blockage of air-cooling passages.
4. Check door and protective device interlocking by:
  - a. Closure attempt of device when door is open.
  - b. Opening attempt of device when door is closed.
5. Check nameplates for proper identification in accordance with drawings.
6. Compare control wiring to schematic diagrams.
7. Check control wiring for proper bundling, identification, termination, and connection.
8. Exercise active components.
9. Inspect contactors for correct mechanical operations, correct contact gap, wipe, alignment, and pressure, and correct torque of connections.



10. Compare motor protector with motor characteristics for proper size.

**B. Perform the following tests:**

1. Test for insulation resistance from phase-to-phase and phase-to-ground on motor protector and 480V power wiring.
2. Test for insulation resistance from phase-to-ground and across open contacts on contactor.
3. With control voltage applied, test voltage levels at each point on terminal board and each device terminal.
4. Perform operational test by initiating control devices to affect proper operation.

**3.14 TRANSFER SWITCHES**

**A. Inspect for the following:**

1. Inspect doors and panels for proper interlocking.
2. Inspect mechanical and electrical interlock between normal and alternate sources.
3. Check for proper operation:
  - a. Manual transfer from normal to alternate and back.
  - b. Generator under load and no-load conditions.
  - c. Auto-exerciser of generator under load and no-load conditions.

**B. Perform the following tests:**

1. Test for insulation resistance with a 1,000-volt megaohm meter from phase-to-phase and phase-to-ground. Perform this test with switch closed in both source positions.
2. Perform contact resistance test across each blade for both source positions.
3. Verify operation and timing of:
  - a. Normal and alternate voltage sensing relays.
  - b. Engine-start sequence.
  - c. Timing delay upon transfer and retransfer.
  - d. Engine cooldown and shutdown.

**3.15 STANDBY GENERATOR SYSTEMS**

- A. Conform to NFPA 110.**

**B. Inspect for the following:**

1. Visual and Mechanical Inspection:
  - a. Inspect for proper electrical and grounding connections.
  - b. Inspect for blockage of air inlet and exhaust.
  - c. Inspect for proper operation of heaters.
  - d. Inspect for proper operation of battery charger.
  - e. Inspect integrity of engine cooling and fuel supply systems.
  - f. Inspect cooling liquid type and level.
  - g. Compare nameplate rating and connection with one-line diagram.

**C. Perform the following tests:**

1. Operate generator and check for:
  - a. Excessive noise.
  - b. Overheating of engine or generator.
  - c. Correct rotation.
  - d. Excessive vibration.
2. Inspect for proper operation of meters and instruments.
3. Perform phase rotation tests.
4. Test engine protective shutdown features for low oil pressure, overtemperature, and overspeed.
5. Test Report: Record and report the following:
  - a. Electric load on generator.
  - b. Fuel consumption.
  - c. Exhaust temperature.
  - d. Ambient air temperature.
  - e. Safety shutdown performance results.
6. After completion of performance tests, manufacturer shall make final adjustments, replace fuel and oil filters, and check belt drive tensions.

7. Demonstrate to OWNER proper operation of control and transfer between normal power and standby power in both directions, including all shedding of non-essential loads.

- END OF SECTION -

## SECTION 26 05 10 - LOW-VOLTAGE AC ELECTRIC MOTORS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The provisions of this section apply to low-voltage, three-phase or single-phase, alternating current (ac), squirrel-cage induction motors throughout the Contract Documents, except as indicated otherwise.
- B. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the OWNER'S REPRESENTATIVE.

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **National Electrical Manufacturers Association (NEMA)**

MG 1            Motors and Generators

##### **Underwriter's Laboratories (UL)**

83              Standard for Thermoplastic-Insulated Wire and Cable

2111           Standard for Overheating Protection for Motors

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. Complete motor data shall be submitted with the driven machinery shop drawings. Motor data shall include:
  - 1. Machine name and specification number of driven machine.
  - 2. Motor manufacturer.
  - 3. Motor type or model and dimensional drawing, and motor weight.
  - 4. Nameplate data in accordance with NEMA MG 1:
    - a. Nominal horsepower.
    - b. NEMA design.
    - c. Enclosure type and mounting orientation.
    - d. Frame size.
    - e. Winding insulation class and temperature rise class.

- f. Voltage, phase, and frequency ratings.
- 5. Service factor.
- 6. Full load current at rated horsepower for application voltage.
- 7. Locked rotor current.
- 8. No load current.
- 9. Full load speed.
- 10. Guaranteed minimum full load efficiency, and nominal efficiencies at 1/2 and 3/4 load.
- 11. Guaranteed minimum full load power factor, and nominal power factor at 1/2 and 3/4 load.
- 12. Bearing type, lubrication, and life data.
- 13. Recommendations for lubricants of relubricatable-type bearings.
- 14. Conduit box dimensions and usable volume.
- 15. Type of thermal protection or overtemperature protection, if included.
- 16. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable.
- 17. Motor sound power level in accordance with NEMA MG 1.
- 18. Maximum brake horsepower required by the equipment driven by the motor.
- 19. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery.
- 20. Description of submersible motor moisture sensing system.
- 21. Seismic anchorage and bracing data sheets and drawings as required by Section 43 00 00 – Equipment General Provisions.

**C. O&M Data:**

- 1. In accordance with Section 01 33 00 – Contractor Submittals.
- 2. Seismic anchorage and bracing calculations as required by Section 43 00 00 – Equipment General Provisions.
- 3. Factory test reports.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURERS, OR EQUAL**

- A. U.S. Motors.**
- B. General Electric.**
- C. Reliance Electric.**
- D. MagneTek.**
- E. Baldor.**
- F. TECO-Westinghouse Motor Co.**
- G. WEG.**

### **2.2 GENERAL REQUIREMENTS**

- A.** Electric motors driving identical machines shall be identical.
- B.** Drive motor, driven equipment, and specified motor accessories shall be supplied from a single supplier.
- C.** Meet requirements of NEMA MG 1.
- D.** Motors for driven equipment shall be designed for the intended use and service conditions, with a NEMA design letter classification to fit the application.
- E.** Provide lifting lugs on motors weighing 100 lb. or more.
- F.** Maximum motor loading shall be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.
- G. Motor Capacity:**
  - 1.** The CONTRACTOR shall size motors for the larger of the following criteria:
    - a.** Size motors to continuously carry the maximum load that develops across the full range of driven equipment operation.
    - b.** Size motors for minimum size indicated.
  - 2.** In every case, motor size shall be derated from nameplate values as follows:
    - a.** Ambient Temperature:
      - 1)** For ambient temperatures up to but not exceeding 40 degrees C, no derating is required.

- 2) For ambient temperatures exceeding 40 degrees but less than 50 degrees C, derate nameplate horsepower ratings to 85 percent.
  - b. Site Altitude: No derating is required for altitudes less than 3,300 feet (1,000 meters).
  3. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the WORK.
- H. **Exempt Motors:** Motors for valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these requirements to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

## 2.3 DESIGN REQUIREMENTS

- A. Electric motors shall comply with NEMA MG 1. Motors used with adjustable frequency drives shall comply with NEMA MG 1, Part 31.
- B. **NEMA Design:** Electric motors shall be NEMA Design B, unless otherwise indicated. In no case shall starting torque or breakdown torque be less than the value in NEMA MG 1. Motors shall be suitable for the indicated starting method.
- C. **Motor Voltage Ratings:** Low-voltage motors shall have voltage ratings in accordance with the following, unless otherwise indicated:
  1. Motors 1 HP and smaller shall be rated 115 volts, single-phase, 60 Hz. Dual voltage motors rated 115/230 volts, 115/208 volts, or 120/240 volts are acceptable, provided all leads are brought out to the conduit box.
  2. Motors larger than 1 HP, but less than 3 HP shall be rated 208 volts, three-phase or single-phase, 60 Hz. Dual voltage motors rated 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.
  3. Motors 3 HP and larger shall be rated 460 volts, three-phase, 60 Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.
- D. **Insulation:**
  1. Three-phase motors shall have Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1.
  2. Single-phase motors shall have Class F insulation with temperature rise not to exceed the insulation class.

3. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1,600 volt spikes, with dV/dt as defined in NEMA MG 1-31.
- E. **Enclosure:** Motors 50 HP or smaller located in non-hazardous areas shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated. Furnish with drain hole with porous drain/weather plug.
- F. **Premium Efficiency Motors:**
  1. Motors with a nameplate rating of 1 HP and larger shall be premium efficient units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.
  2. Nominal efficiency and minimum efficiency shall be defined in accordance with NEMA MG 1 for the type of motor provided.
- G. **Power Factor:** Manufacturer's standard for guaranteed minimum at full load.
- H. Locked rotor kVA code shall be F or lower, if not covered by NEMA MG 1 tables.
- I. Two-speed motors shall be of the two-winding type.

## 2.4 ACCESSORY REQUIREMENTS

- A. Motors shall have split-type, oversized cast metal conduit boxes. Motors other than open drip-proof shall be gasketed. Minimum usable volume shall be in accordance with NEMA MG 1 and NFPA 70.
- B. **Special Requirements:** The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.
- C. **Grounding Lugs:** Provide motor grounding lug suitable to terminate ground wire, sized as indicated.
- D. **Nameplate:** Motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA standard motor data in conformance with NEMA MG 1.
- E. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

## 2.5 MOTOR THERMAL PROTECTION

- A. **Single Phase Motors:** Single-phase 115-, 208-, or 230-volt motors shall have integral thermal overload protection or shall be inherently current-limited.



**B. Thermostats:**

1. Winding thermostats, provided where required by driven equipment supplier, shall be bi-metallic, temperature-actuated switches.
2. Thermostat contacts shall be normally closed contacts rated 5A at 120 volts ac and embedded in stator windings.
3. Thermostat contacts shall automatically reset.
4. The thermostat switch point shall be pre-calibrated by the manufacturer.

**2.6 MOTOR BEARINGS**

- A. Bearings shall conform to Section 43 00 00 – Equipment General Provisions, except as indicated herein.
- B. Motors greater than 1 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.
- C. **Fractional Horsepower:** Motors with fractional horsepower through 1 HP shall be provided with lubricated-for-life ball bearings.
- D. **Horizontal Motors Over 1 HP:** Motors larger than 1 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.
- E. **Vertical Motors Over 1 HP:** Vertical motors larger than 1 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

**2.7 SUBMERSIBLE MOTORS**

- A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.
- B. Motor shall be capable of running dry continuously.
- C. **Enclosure:** Hermetically sealed, watertight, for continuous submergence up to 70 feet of depth.
- D. **Bearing and Lubrication:** Permanently sealed and lubricated, with replaceable antifriction guide and thrust bearings. Minimum 15,000 hours L-10 bearing life.
- E. Locked rotor kVA code shall be F or lower.
- F. **Connecting Cables:**
  1. Unless noted otherwise, each motor shall have one cable containing power, control, and grounding conductors.

2. Cables shall be suitable for hard service, submersible duty with watertight seal at motor cable entrance.
3. Length: 70 feet minimum, or manufacturer's standard.
4. UL 83 listed and sized in accordance with NFPA 70.

## 2.8 FACTORY TESTING

- A. Perform In accordance with IEEE 112 for polyphase motors.
- B. Routine tests in accordance with NEMA MG 1.
- C. For energy efficient motors, test efficiency and power factor at 1/2, 3/4, and full load.
- D. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors.
- E. Test report shall indicate test procedure and instrumentation used to measure and record data.
- F. Test report shall be certified by the motor manufacturer's test personnel.

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment.
- B. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 26.
- C. Align motor carefully and properly with driven equipment.
- D. Secure equipment to mounting surface with anchor bolts.

### 3.2 FIELD TESTING

- A. The CONTRACTOR shall perform the following field tests:
  1. Inspect each motor installation for any deviation from rated voltage, phase, frequency, and improper installation.
  2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage.
  3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment.
5. Visually check that motor overload heaters are properly sized and that MCP breaker settings are correct for the motor installed.
6. Test insulation (megger test) of new and re-used motors in accordance with NEMA MG 1. Test voltage shall be 1,000 VAC plus twice the rated voltage of the motor.

- END OF SECTION -

## **SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS**

### **PART 1 -- GENERAL**

#### **1.1 RELATED SECTIONS**

A. Refer to the following sections for other requirements related to this section:

1. Section 26 05 43 – Underground Raceway Systems.

#### **1.2 REFERENCE STANDARDS**

A. The following is a list of standards which may be referenced in this section:

##### **ASTM International**

A123/123M	Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A240/A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

##### **National Electrical Manufacturers Association (NEMA)**

C80.1	Electric Rigid Steel Conduit (ERSC)
C80.6	Electrical Intermediate Metal Conduit (EIMC)
TC 2	Electrical Polyvinyl Chloride (PVC) Conduit
TC 3	Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
TC 6	Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

##### **Telecommunications Industry Association (TIA):**

569B	Communication Building Standard for Telecommunications Pathways and Spaces
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##### **Underwriters Laboratories Inc. (UL)**

6	Electrical Rigid Metal Conduit – Steel
360	Standard for Liquid-Tight Flexible Metal Conduit
514A	Metallic Outlet Boxes

514B	Conduit, Tubing, and Cable Fittings
651	Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
870	Standard for Wireways, Auxiliary Gutters, and Associated Fittings
1242	Standard for Electrical Intermediate Metal Conduit – Steel
1990	Standard for Nonmetallic Underground Conduit with Conductors

### 1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

**B. Product Data:**

1. Submit catalog cuts on the following:
  - a. Rigid galvanized steel conduit.
  - b. Intermediate metal conduit.
  - c. PVC Schedule 80 conduit.
  - d. Flexible metal, liquid-tight conduit.
  - e. Conduit fittings.
  - f. Wireways.
  - g. Large junction and pullboxes.

## PART 2 -- PRODUCTS

### 2.1 CONDUIT

**A. Rigid Galvanized Steel (RGS) Conduit:**

1. Rigid steel conduit shall be manufactured in accordance with NEMA C80.1 and UL 6.
2. Rigid steel conduit shall be manufactured of mild steel, hot-dip galvanized inside and out, with additional protective coating.

**B. Intermediate Metal Conduit (IMC):**

1. Intermediate metal conduit shall be manufactured in accordance with NEMA C80.6 and UL 1242.
2. Intermediate metal conduit shall be manufactured of mild steel, hot-dip galvanized inside and out, with additional protective coating.

C. Electrical Metallic Tubing (EMT) will not be accepted.

**D. Rigid Nonmetallic Conduit:**

1. Rigid nonmetallic conduit shall be manufactured in accordance with NEMA TC 2 and UL 651.
2. Rigid nonmetallic conduit shall be of Schedule 80 PVC.
3. Rigid nonmetallic conduit shall be UL listed for concrete encasement, underground direct burial, sunlight exposure, and 90 degrees C insulated conductors.

**E. Liquid-Tight Flexible Metal Conduit:**

1. Liquid-tight flexible conduit shall be constructed of a flexible galvanized metal core with a sunlight-resistant, extruded thermoplastic outer jacket.
2. Liquid-tight flexible conduit shall be manufactured in accordance with the requirements of UL 360 for 105 degrees C insulated conductors.

## 2.2 FITTINGS

A. Cast and malleable iron fittings for use with metallic conduit shall be of the threaded type with 5 full threads.

**B. Gaskets and Covers:**

1. Fittings shall be provided with neoprene gaskets and non-magnetic stainless steel screws.
2. Covers shall be attached by means of holes tapped into the body of the fitting.
3. Covers for fittings attached by means of clips or clamps will not be accepted.

**C. Terminations:**

1. In wet areas, conduit shall be terminated in rain tight hubs as manufactured by **Myers, O.Z. Gedney**, or equal.
2. In general industrial areas, sealed locknuts and bushings shall be used.

**D. Rigid Steel Conduit and Intermediate Metal Conduit Fittings:**

1. Rigid steel conduit fittings shall be manufactured in accordance with UL 514B.
2. Fittings for use with galvanized steel conduit shall be of malleable iron or gray-iron alloy with zinc plating.
3. Conduit Bodies: Sized in accordance with NFPA 70.
4. Cable Sealing Fittings:

- a. Provide to form watertight nonslip cable connection to conduit.
  - b. For conductors with small outer diameters (1/2-inch or less): Provide neoprene bushing at connector entry.
5. Manufacturers, or Equal:
  - a. **O.Z. Gedney.**
  - b. **Crouse-Hinds.**
  - c. **Appleton.**

**E. PVC Fittings:**

1. PVC Fittings shall be manufactured in accordance with NEMA TC 3.
2. Fittings for use with rigid non-metallic conduit shall be manufactured of PVC, of the solvent welded type.
3. Provide welding solvent as required for the installation of PVC conduit and fittings.
4. Manufacturers, or Equal:
  - a. **Carlton.**
  - b. **Crouse-Hinds.**
  - c. **Hoffman.**

**F. Liquid-Tight Flexible Metal Fittings:**

1. Fittings for use with liquid-tight flexible metal shall be of mild steel with zinc plating and protective coating.
2. Liquid-tight, insulated throat connectors with integral nylon or plastic bushing and sealing O-rings.
3. Manufacturers, or Equal:
  - a. **O.Z. Gedney; Series 4Q.**
  - b. **Thomas & Betts; Series 5331.**

**2.3 BOXES**

**A. Outlet and Device Boxes:**

1. Boxes for use with steel conduit shall be of malleable iron or gray-iron alloy with zinc plating.
2. Boxes shall have threaded hubs and cast-mounted lugs.

3. Cast Iron:
  - a. Malleable iron or gray-iron alloy with zinc plating.
  - b. Threaded hubs and cast-mounted lugs.
4. Covers shall be same material as box, with neoprene gaskets and non-magnetic stainless steel screws.
5. Manufacturers, or Equal:
  - a. **Crouse-Hinds; FS or FD series.**
  - b. **Appleton; FS or FD series.**
  - c. **Killark; FS or FD series.**

**B. Junction and Pullboxes:**

1. Outlet boxes, as specified under Paragraph Outlet and Device Boxes, are acceptable for use as junction and pullboxes.
2. Conduit bodies, as specified under Paragraph Fittings, are acceptable for use as junction boxes.
3. At or Below Grade Boxes: In accordance with Section 26 05 43 – Underground Raceway Systems.
4. Large Boxes:
  - a. NEMA 250 Type 1 rated, steel enclosure with ANSI gray finish for dry areas.
  - b. NEMA 250 Type 12 rated, steel enclosure with ANSI gray finish for general industrial areas.
  - c. NEMA 250 Type 3R rated, steel enclosure with ANSI gray finish for outdoor or wet areas.
  - d. NEMA 250 Type 4 rated, steel enclosure with ANSI gray finish for wet areas with splashing or spraying water.
  - e. Steel boxes shall be a minimum of 14-gauge thickness.
  - f. Covers shall be hinged with clamps with neoprene gasket.

**2.4 WIREWAY**

- A. The wireway shall be of the lay-in type and shall be NEMA-rated for the area in which it is to be installed in accordance with the requirements of Section 26 00 00 – Basic Electrical Requirements.



- B. Power, control, signal and communications cables shall be separated by grounded metallic dividers in wireways or shall be run in separate wireways.

C. **Fittings and Covers:**

- 1. Fittings and sections shall have non-magnetic stainless steel screws.
- 2. Covers shall be attached by hinges and clamps to the bodies.
- 3. Covers attached by means of clips or screws will not be accepted.
- 4. Covers and bodies shall be a minimum of 14-gauge steel construction.

D. **Grounding:**

- 1. Metallic wireway bodies shall be grounded.
- 2. Dividers shall be steel with steel wireways and shall be grounded by means of an individual grounding conductor.
- 3. Non-metallic dividers will not be accepted.

2.5 ACCESSORIES

A. **Wraparound Duct Band:**

- 1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
- 2. Width: 50 mm minimum.
- 3. Manufacturers, or Equal:
  - a. **Raychem; Type TWDB.**

**PART 3 -- EXECUTION**

3.1 GENERAL

- A. Wiring shall be run in raceway unless indicated otherwise.
- B. Raceways shall be installed between equipment as indicated.
- C. Raceway systems shall be electrically and mechanically complete before conductors are installed.
- D. **Bends and Offsets:**
  - 1. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose.
  - 2. Factory elbows shall be utilized wherever possible.

**E. Routing:**

1. Where raceway routings are indicated, follow those routings to the extent possible.
2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and in strict accordance with the NEC as well as customary installation practice.
3. Raceway shall be encased, exposed, concealed, or under-slab as indicated, except that conduit in finished areas shall be concealed, unless specifically indicated otherwise.
4. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.
5. Raceway routings, whether indicated or not, shall be adjusted to avoid structural and/or mechanical obstructions, to preserve headroom, and to keep openings and passageways clear.
6. Exposed raceways shall be installed parallel or perpendicular to structural beams.

**F. Coordination:**

1. Coordinate between trades prior to installing the raceways.
2. The lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be by the CONTRACTOR as part of the WORK.

G. Support rod attachment for ceiling-hung trapeze shall meet the seismic requirements in the area where the Project is located.

H. Wireways shall be supported in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – Basic Electrical Requirements.

**I. Expansion Fittings:**

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.
2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension and where conduits transition out of structures in locations where differential settlement may occur.
3. Encased Expansion Fittings:
  - a. Install encased expansion fittings wherever encased conduits cross building expansion joints.
  - b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.

4. Expansion and expansion/deflection fittings shall be of the same material as the raceway to which they are installed.
  - J. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.
  - K. Exposed raceways shall be installed at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways shall be installed at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
  - L. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.
- 3.2 CONDUIT
- A. Size: 3/4-inch minimum trade size.
  - B. Exposed conduit shall be RGS or IMC, unless indicated otherwise.
  - C. Conduit encased in concrete shall be Schedule 80 PVC, unless noted otherwise.
  - D. Conduit and duct banks buried in soil shall be in accordance with the requirements of Section 26 05 43 – Underground Raceway Systems.
  - E. Transitions from underground to exposed shall be in accordance with the requirements of Section 26 05 43 – Underground Raceway Systems.
  - F. Supports shall be installed at distances required by the NEC.
  - G. **Concrete Encasement:**
    1. Where PVC conduit is stubbed up from a concrete encasement, an RGS elbow with a single layer of wraparound duct band shall be utilized. Wraparound duct band shall extend at least 2 inches above and 2 inches below concrete surface.
    2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.
    3. Conduit shall not be encased in the bottom floor slab below grade.
  - H. **Penetrations:**
    1. Conduit passing through walls or floors shall have plastic sleeves.
    2. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.
  - I. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:

1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section.
  2. Conduits shall not be larger in outside dimension than one-third the overall thickness of the slab, wall, or beam in which it is embedded.
  3. Conduits shall not be spaced closer than 3 outside diameters on centers.
- J. The conduit shall be placed such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- K. Threads shall be coated with a conductive lubricant before assembly.
- L. **Joints:**
1. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  2. Conduit shall be adequately reamed in order to prevent damage to the wires and cables inside.
  3. Strap-wrenches and vises shall be used to install conduit in order to prevent wrench marks on the conduit.
  4. Conduit with wrench marks shall be replaced.
- M. **Slope:**
1. Wherever possible, conduit runs shall slope to drain at one or both ends of the run.
  2. Wherever conduit enters a substructure below grade, the conduit shall be sloped in order to drain water away from the structure.
  3. Extreme care shall be taken in order to avoid pockets or depressions in the conduit.
- N. **Connections:**
1. Connections to motors, HVAC equipment, and other equipment subject to vibration shall be made with liquid-tight flexible metal conduit not exceeding 4 feet in length.
  2. Equipment subject to vibration that is normally provided with wiring leads shall be provided with a cast junction box for the make-up of connections.
- O. **Empty Conduits:**
1. Empty conduits shall be tagged at both ends to indicate the final destination.
  2. Where it is not possible to tag the conduit, the destination shall be identified by a durable marking on an adjacent surface.
  3. A pull-cord shall also be installed in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes shall have a removable plug installed.

**P. Identification of Conduits:**

1. Conduits shall be identified at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Conduits not assigned a unique number in the Contract Documents shall have a unique number assigned by the CONTRACTOR following the numbering scheme used in the Contract Documents.
4. Conduit identification shall be by a stamped or engraved non-corroding metal tag attached to the conduit bushing.
5. Markings with a pen or paint will not be accepted.

**Q. Identification of Pullboxes and Junction Boxes:**

1. Pullboxes and junction boxes shall be identified.
2. Identification shall be the unique conduit number assigned in the Contract Documents or by a unique number assigned by the CONTRACTOR following the numbering scheme used in the Contract Documents.
3. Box identification shall be by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – Basic Electrical Requirements, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- R. Conduit for data cables shall be provided in accordance with the equipment manufacturer's recommendations, especially regarding separation from low and medium voltage power raceways.

- END OF SECTION -

## SECTION 26 05 43 - UNDERGROUND RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 RELATED SECTIONS

- A. Refer to the following sections for other requirements related to this section:
  - 1. Section 26 05 33 – Electrical Raceway Systems.

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **ASTM International**

C857                      Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.
- B. **Product Data:**
  - 1. Submit catalog cuts on the following, marked where applicable to show proposed materials and finishes:
    - a. Junction and pullboxes used at or below grade.
    - b. Handholes, including dimensional drawings and loading information.
- C. **Record Drawings:**
  - 1. Show routings, burial depths, handhole locations and sizes, and where applicable, connections to drainage systems.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Handholes, pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

#### 2.2 HANDHOLES AND PULLBOXES

- A. Handholes and pullboxes shall be precast concrete with construction and load rating as indicated.
- B. **Covers and Frames:**

1. Covers shall be traffic type, H-20 loading.
  2. Handhole covers shall be hinged, galvanized steel diamond plate, with torsion springs.
  3. Pullbox covers shall be steel diamond plate with locking bolts.
  4. Covers shall be identified as "Electric" by raised letters cast into the covers.
  5. Covers and lids shall be bolted to cast-in-place steel frames with galvanized steel hardware.
  6. Handholes and pullboxes shall have frost-proof and water-tight grey iron frames.
  7. Handhole frames shall have a 1/2-inch drilled and tapped hole and lug to accommodate a #4/0 AWG bare stranded copper conductor connected to a ground rod and the ground conductor of power cables passing through the handhole.
- C. Provide knockout panels or precast individual raceway openings on all four sides of handholes.
- D. Slope floors toward drain points, leaving no pockets or other non-draining areas.
- E. Handholes shall be equipped with pulling-in irons opposite and below each ductway entrance.
- F. Handholes shall have solid bottom slabs. Open bottom handholes will not be accepted.
- G. Open bottom pullboxes are acceptable for use.
- H. PVC duct bank conduits shall be provided with end bells.
- I. Brackets, **Unistrut Cat. No. P2515** or equal and 60-inch concrete inserts, **Unistrut Cat. NO. P3261** or equal, shall be provided in handholes as required for racking wiring through handholes.
- J. Precast handholes and pullboxes shall be **Jensen Precast, Mack, Oldcastle, U.S. Precast**, or equal.

## 2.3 DUCT BANKS

- A. Underground ducts and fittings shall be Schedule 80 PVC or RGS in accordance with Section 26 05 33 – Electrical Raceway Systems.
- B. **Spacers:**
1. Modular:
    - a. Nonmetallic, interlocking, suitable for multiple conduit sizes.
    - b. Manufacturers, or equal:

- 1) **Carlton.**
- 2) **Underground Device, Inc.**

2. Template:

- a. HDPE or polypropylene, custom-fabricated one-piece spacers.
- b. 1/2-inch minimum thickness, with conduit openings 1 inch larger than conduit outside diameter.

C. **Wraparound Duct Band:**

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturers, or Equal:
  - a. **Raychem; Type TWDB.**

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. Underground raceways shall be installed between handholes and pullboxes as indicated, and as required.
- B. Where used in direct bury applications, RGS conduit shall have wraparound duct band applied along entire length with one-half tape width overlap to obtain two complete layers.
- C. Raceway systems shall be electrically and mechanically complete before conductors are installed.
- D. Bends and offsets shall be smooth and symmetrical, and shall be fabricated with tools designed for this purpose. Factory elbows shall be utilized wherever possible.
- E. Raceway routings on plan views shall be followed to the extent possible.
- F. Routings shall be adjusted to avoid obstructions. Coordinate the trades prior to installation of raceways. Lack of coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be performed by the CONTRACTOR as part of the WORK.

### **3.2 HANDHOLES AND PULLBOXES**

- A. Excavation, shoring, bracing, backfill, and final grade in accordance with Section 31 00 00 – Earthwork.
- B. Do not install until final raceway grading has been determined.
- C. Install handholes and pullboxes flush with finished grade.



- D. Install such that raceway enters at nearly right angle and as near as possible to end, unless otherwise shown.
- E. **Grounding:** As specified in Section 26 01 00 – Basic Electrical Materials and Methods.
- F. Obtain OWNER'S REPRESENTATIVE's written acceptance prior to installation in paved areas, roadways, or walkways.
- G. Use boxes and covers suitable to support anticipated weights.
- H. Sections of pre-fabricated handholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 6-inch bed of gravel, as recommended by the manufacturer or as required by field conditions.

### 3.3 DUCT BANKS

- A. Duct shall be assembled using spacers and saddles to provide conduits with vertical and horizontal separation in trench. Install spacers at intervals in accordance with NFPA 70 for the duct type used, but in no case greater than 10 feet.
- B. The duct array shall be supported and/or anchored to prevent movement during backfill.
- C. The duct shall be laid on a grade line of at least 3 inches per 100 feet, sloping towards pullboxes or handholes.
- D. Duct shall be installed and pullbox and handhole depths adjusted so that the top of the duct envelope is a minimum of 12-inches below grade and a minimum of 24-inches below roadways.
- E. Changes in direction of the duct envelope by more than 10 degrees horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter.
- F. Duct couplings shall be staggered a minimum of 6-inches.
- G. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
- H. Provide expansion/deflection fittings in conduit runs that exit building or structure below grade. Conduit from wall or structure to fitting shall be RGS conduit with two overlapping layers of wraparound duct band.
- I. Transitions from underground to exposed shall be RGS conduit with two overlapping layers of wraparound duct band. Wraparound duct band shall extend at least 2 inches above and 2 inches below grade.
- J. Buried, vertical 90-degree elbows shall be RGS conduit with two overlapping layers of wraparound duct band.
- K. The bottom of trench shall be of select backfill or sand. Controlled low-strength material (CLSM) is an acceptable bedding and duct zone material.

- L. Each bore of the completed duct bank shall be cleaned by drawing through it a standard flexible mandrel one-foot long and 1/4-inch smaller than duct inside diameter. After passing of the mandrel, a wire brush and swab shall be drawn through.
- M. Duct entrances shall be grouted smooth; ducts shall be terminated with flush end bells.
- N. Duct bank penetration through walls of handholes, pullboxes, and building walls below grade shall be watertight.
- O. Where an underground conduit enters a structure through a concrete roof or a membrane waterproofed wall or floor, provide a **Link-Seal**, or equal sealing device. The sealing device shall be utilized with rigid steel conduit.
- P. Do not backfill until inspected by OWNER'S REPRESENTATIVE.
- Q. **Spare Raceways:**
  - 1. Spare raceways shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.
  - 2. Provide with permanent, removable cap over each end.
  - 3. Provide PVC plug with pull tab for underground raceways with end bells.
  - 4. Identify as specified in Paragraph Identification Devices.
- R. **Identification Devices:**
  - 1. Raceway Tags: Identify origin and destination using waterproof tags at each end and at each intermediate pull point. Provide nylon strap for attachment.
  - 2. Warning Tape: Continuous lengths of underground warning tapes shall be installed 12-inches above and parallel to duct banks, aligned with centerline of run. Tape shall be 6-inches wide polyethylene film imprinted "CAUTION – ELECTRIC UTILITIES BELOW."

- END OF SECTION -

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## **SECTION 26 05 83 - WIRE & CABLE**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### **1.2 REFERENCE STANDARDS**

- A. The following is a list of standards which may be referenced in this section:

##### **ASTM International**

B3	Standard Specification for Soft or Annealed Copper Wire
B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
B496	Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

##### **National Electrical Manufacturers Association (NEMA)**

WC 70	Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
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##### **Underwriters Laboratories, Inc. (UL)**

44	Standard for Thermoset-Insulated Wires and Cables
83	Standard for Thermoplastic-Insulated Wires and Cables
486A-486B	Standard for Safety for Wire Connectors
486C	Standard for Safety for Splicing Wire Connectors
510	Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
854	Standard for Safety for Service-Entrance Cables
1277	Standard for Electrical Power and Control Tray Cables

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

##### **B. Product Data:**

1. Each type of wire and cable used for the WORK.
2. Outer diameter and cross-sectional area of overall wire or cable.

3. Insulation type of each wire, including those contained in cables.
4. Jacket type of each cable.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Conductors, including grounding conductors, shall be copper in accordance with ASTM B3.
- B. Conductor sizes smaller than #8 AWG shall be stranded per ASTM B8. Conductor sizes #8 AWG and larger shall be stranded per ASTM B496.
- C. Aluminum conductor wire and cable will not be permitted, unless specifically indicated otherwise.
- D. Insulation shall bear UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size.
- E. All conductors, except conductors that form an integral part of equipment such as motors and controllers, shall conform to the requirements of Article 310 of NFPA 70, National Electrical Code (NEC) for current carrying capacity.

### **2.2 LOW VOLTAGE WIRE AND CABLE**

#### **A. Power and Lighting Wire:**

1. Wire shall be UL listed and conform to requirements of NEMA WC 70 and shall have VW-1 flame rating.
2. THHN/THWN-2 insulation shall meet or exceed UL 83.
3. XHHW-2 insulation shall meet or exceed UL 44.
4. Wire shall be rated for 600 volts in duct or conduit for power and lighting circuits and shall be type THHN/THWN-2 insulation for sizes #8 AWG and smaller, and type XHHW-2 insulation for sizes #6 AWG and larger.
5. Power Conductor Sizes:
  - a. #12 AWG minimum.
  - b. Lighting and Receptacle Circuits: #12 AWG, unless noted otherwise.
6. Provide stranded conductors for all circuits.
7. Equivalent parallel sets of conductors are only acceptable when specifically approved by OWNER'S REPRESENTATIVE.
8. CONTRACTOR shall upsize branch conductors to prevent voltage drop from exceeding 3 percent at the farthest connected load or combination of such loads and

where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

9. Manufacturer, or Equal:

- a. **Southwire.**
- b. **Okonite.**
- c. **General Cable.**

**B. Control Wire:**

- 1. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.
- 2. Control wiring shall be minimum #14 AWG, unless noted otherwise.
- 3. Control wires at panels and cabinets shall be machine tool grade type MTW, UL approved, and rated for 90 degrees C at dry locations.

**C. Control Cable:**

- 1. Multiconductor cable rated 600V, consisting of overall jacket and ASTM B3/B8 stranded copper conductors, for use in conduits, ducts, troughs, trays, and direct burial.
- 2. Cable shall be UL listed to UL 1277, UL 1685, and UL 1581, and conform to requirements of NEMA WC 70.
- 3. Individual conductors shall be #14 AWG and have THHN/THWN insulation. Conductors shall meet or exceed UL 83.
- 4. Color coding shall be in accordance with ICEA S-58-679 Method 1, Table 2.
- 5. Overall jacket shall be PVC.
- 6. Conductor group shall be bound with binder tape inside jacket.
- 7. Manufacturer, or Equal:
  - a. **Southwire.**
  - b. **Okonite.**

**D. Instrumentation Cable:**

- 1. Conductors shall be stranded per ASTM B8.
- 2. Instrumentation cable shall be rated 600 volts and for use in cable tray and shall conform to UL 1277.

3. Individual conductors shall be #16 AWG stranded, tinned copper. Insulation shall be color coded PVC: black-red for each pair or black-white-red for each triad, with each pair or triad numbered uniquely.
4. Twisted, shielded pair cable (TSP) shall be composed of two twisted conductors, an aluminum polyester foil overall shield, a #18 AWG stranded, tinned copper drain wire, and a PVC outer jacket.
5. Twisted, shielded triad cable (TST) shall be composed of three twisted conductors, an aluminum polyester foil overall shield, a #18 AWG stranded, tinned copper drain wire, and a PVC outer jacket.
6. Utilize only single-pair or single-triad cable, unless otherwise approved by OWNER'S REPRESENTATIVE.
7. Nominal Outer Diameter:
  - a. TSP: 0.29 inches.
  - b. TST: 0.31 inches.
8. Manufacturer, or Equal: **Okonite; Okoseal-N Type P-OS.**

**E. Ethernet/IP (Category 6) Data Cable:**

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568 C Category 6 requirements.
2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
3. Provide four each individually twisted pair, #23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer, or Equal: **Belden; 7852A.**

**F. Modbus RTU Serial Data Cable:**

1. Modbus RTU cable shall be UL listed and rated at 300 volts for use in cable tray (power-limited tray cable).
2. Conductors: Single triad or two pairs of PE-insulated, #24 AWG conductors. Each conductor shall be 7-strand tinned copper. Third conductor shall be connected as a ground reference wire.

3. Terminations:
  - a. RS485 connectors, unless indicated otherwise. Provide mating connectors as required to land cable at equipment-specific port or terminal block.
  - b. Provide terminating resistors as required for a complete Modbus RTU serial installation.
4. Shield: Overall aluminum/synthetic shield, overlapped to provide 100 percent coverage.
5. Drain: Tinned copper braid and #24 AWG drain wire, braid overlapped to provide at least 65% coverage.
6. Outer Jacket: Sunlight- and oil-resistant PVC.
7. Characteristic Impedance: 120 Ohms.
8. Nominal Outer Diameter: 0.34 inches.
9. Manufacturer, or Equal: **Belden; 9842**, or triad equivalent.

## 2.3 SPLICES AND TERMINATIONS

- A. Connectors shall be listed to UL 486A-486B.
- B. Splices shall be listed to UL 486C.
- C. Insulating tape shall be listed to UL 510.
- D. Compression connectors shall be straight, single- or double-hole, tin-plated copper lugs.
- E. Threaded connectors shall be split-bolt type of high-strength copper alloy.
- F. Crimp-on connectors shall be pre-insulated fork or ring type terminations.
- G. Pressure type, twist-on connectors will not be acceptable.
- H. Splices shall be heat-shrinkable butt-splice type.
- I. Splices and Terminations Manufacturers, or Equal:
  1. **Burndy.**
  2. **Thomas & Betts.**
- J. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.
- K. Conductor and cable identification devices shall be printed heat-shrink plastic tubing.



## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. The CONTRACTOR shall provide and terminate power, control, and instrumentation conductors, unless indicated otherwise.
- B. The CONTRACTOR shall, as a minimum, provide the number of wires listed on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps and shall be fanned out to terminals.

### **3.3 COMBINING RACEWAYS**

- A. In general, only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment shall be combined, in accordance with the NEC.
- B. Instrumentation cable shall not be permitted to be combined in the same raceway with power and control wiring.
- C. Wire or cable with insulation rated for 600V shall not be permitted to be combined in the same raceway with wire or cable with insulation rated for 300V or less (power-limited circuits).
- D. Raceways other than those containing instrumentation and power-limited circuits may be combined in strict accordance with the NEC and with prior written permission from the OWNER'S REPRESENTATIVE. Permission from the OWNER'S REPRESENTATIVE does not relieve the CONTRACTOR of responsibility to meet national, state, and local code requirements. Raceways combined as such shall be upsized for conduit fill in accordance with the NEC, which shall not be justification for extra compensation.

### **3.4 SPLICES AND TERMINATIONS**

- A. Wire taps and splices shall be properly taped and insulated according to their respective classes.
- B. Cable splices in underground handholes or pull boxes will not be permitted.
- C. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

- D. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

**E. Power Wire and Cable:**

- 1. Branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
- 2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape over taped with a minimum of 2 layers of high temperature tape.

**F. Control Wire and Cable:**

- 1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
- 2. In junction boxes and control panels, control wire and spare wire shall be terminated to terminal strips.

**G. Instrumentation Wire and Cable:**

- 1. Shielded instrumentation and data cables shall be grounded at one end only. Bond shields to ground at the cabinet, enclosure, or control panel that contains the system programmable logic controller (PLC) or hard-wire logic relaying.
- 2. Pair and triad shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pull boxes. Such cable runs shall have only one splice per conductor. Shields shall be terminated at unique, ungrounded terminal blocks for such splices so as to keep the shield continuous from equipment end to termination at PLC cabinet or enclosure.

**3.5 CABLE IDENTIFICATION**

- A. Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort.
- B. **Unique Designations:** Identify instrumentation and control cables and conductors with the designations indicated in the circuit schedule on the Contract Drawings. The CONTRACTOR shall assign to each control and instrumentation wire and cable not in the circuit schedule a unique designation. Unique designations shall be assigned to conductors having common terminals and shall be shown on the Record Drawings. Designations shall appear within 3 inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, annunciator, or signal purposes.

**1. Multiconductor Cable:**

- a. Identification labels shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment.
- b. Cable designations shall form a part of each individual wire designation.

2. Individual control conductors and instrumentation cable shall be identified at intermediate pull boxes and at stub-up locations beneath free-standing equipment. The instrumentation cable designations shall incorporate the loop numbers assigned in the Contract Documents.
3. Power Conductors:
  - a. All feeder cables and branch circuit conductors shall match industry-standard color-coding practices.
  - b. Insulated ground wire shall be green, and neutral wire shall be white or gray.
  - c. Color coding tape shall be used where colored insulation is not available.
  - d. Color coding and phasing shall be consistent throughout the facility.
  - e. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.
4. General purpose control wire shall be a color distinct from the conductor colors used for power conductors.
5. Spare cable shall be identified with a unique number as well as with destination.
6. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.6 TESTING

- A. **Field Tests:** In accordance with Section 26 01 26 – Electrical Testing.

- END OF SECTION -

## SECTION 26 24 16 - PANELBOARDS & DRY TYPE TRANSFORMERS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. Integrated transformer and panelboard assemblies shall meet the requirements for both transformers and panelboards in this section.
- B. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Panelboard Schedules are located on the drawings.

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **Code of Federal Regulations (CFR)**

10 CFR            Part 431, DOE 2016 Efficiency

##### **Institute of Electrical and Electronic Engineers (IEEE)**

C57.96            Guide for Loading Dry Type Transformers

##### **National Electrical Contractors Association (NECA)**

407                Recommended Practice for Installing and Maintaining Panelboards

##### **National Electrical Manufacturers Association (NEMA)**

289                Application Guide for Ground Fault Circuit Interrupters

AB 1                Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

KS 1                Enclosed Switches

PB 1                Panelboards

PB 1.1            General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

ST 20              Dry-Type Transformers for General Applications

##### **Underwriters Laboratories, Inc. (UL)**

67                  Standard for Panelboards

98                  Standard for Enclosed and Dead-Front Switches

486E                Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors

489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
870	Wireways, Auxiliary Gutters and Associated Fittings
943	Ground-Fault Circuit Interrupters
1449	Standard for Surge Protective Devices
1561	Standard for Dry-Type, General Purpose, and Power Transformers

### 1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 – Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

#### B. **Product Data:**

##### 1. Transformers:

- a. Dimensional drawings and weight.
- b. Descriptive information.
- c. Conduit entry locations.
- d. Transformer nameplate data, including:
  - 1) Voltages.
  - 2) Voltage taps.
  - 3) Winding configuration.
  - 4) Full load kVA.
  - 5) Efficiency.
  - 6) Impedance.
- e. Enclosure rating and type.
- f. Schematic and connection diagrams.
- g. Seismic certification and equipment anchorage details as required by Section 43 00 00 – Equipment General Provisions.

##### 2. Panelboards:

- a. Descriptive information on each type of panelboard, breaker, and accessory provided.
- b. Shop drawings for panelboards.

- c. Conduit entry locations.
- d. Tabulation of Panelboard Features:
  - 1) Circuit Breakers: Type, rating, number of poles, and accessories provided.
  - 2) Provisions for future devices.
  - 3) Component list.
  - 4) Voltage, frequency, phase, and number of incoming wires.
  - 5) Full load current rating.
  - 6) Enclosure type.
  - 7) Bus and terminal bar configurations and ratings.
  - 8) Cable lug sizes.
  - 9) Short circuit current rating of assembled panelboard at system nominal voltage.
  - 10) Auxiliary components, such as surge protective devices.
  - 11) Special features, if indicated.
- e. Installation information.
- f. Seismic certification and equipment anchorage details as required by Section 43 00 00 – Equipment General Provisions.

**C. O&M Data:**

- 1. In accordance with Section 01 33 00 – Contractor Submittals.
- 2. Manufacturer's recommended installation instructions.
- 3. Seismic anchorage and bracing calculations as required by Section 43 00 00 – Equipment General Provisions.

**1.4 QUALITY ASSURANCE**

- A. Provide products that are listed and labeled as defined in NFPA 70.

**PART 2 -- PRODUCTS**

**2.1 TRANSFORMERS**

- A. Low-voltage power transformers submitted under this section shall be dry-type, self-cooled, two-winding, unless indicated otherwise.

- B. Transformers shall be designed, manufactured, and tested in accordance with UL 1561 and NEMA ST 20.
- C. Transformers shall be UL-listed and bear the UL label.
- D. Transformers shall be suitable for use with 75 degrees C wire at ampacities shown in NFPA 70.
- E. Transformers shall meet Department of Energy (DOE) 2016 efficiency requirements at a minimum. Transformers 15 kVA and larger shall comply with California-specific product and usage requirements in Title 20 and Title 24.

**F. Ratings:**

- 1. Power and voltage ratings, and individual transformer configurations shall be as indicated on the Drawings.
- 2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in IEEE C57.96.
- 3. Overload capability shall be in accordance with IEEE C57.96.
- 4. Impedance: Manufacturer's standard.
- 5. Transformer sound levels shall not exceed the following NEMA levels for self-cooled ratings:

Up to 9 kVA	40 dB
10 to 50 kVA	45 dB
51 to 150 kVA	50 dB

**G. Construction:**

- 1. Core and Coil:
  - a. Encapsulated type for single-phase units up to 25 kVA and three-phase units up to 15 kVA.
  - b. Varnish-impregnated type for single-phase units above 25 kVA and three-phase units above 15 kVA.
- 2. Aluminum windings.
- 3. Insulation Systems: Manufacturer's standard design.
- 4. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below rated primary voltage.

5. Wall Brackets: Provide where indicated as wall-mount on Drawings, for units up to 30 kVA.
6. Vibration Isolators:
  - a. Rated for transformer's weight.
  - b. Less than 30 kVA: Isolate entire unit from structure with external vibration isolators.
  - c. 30 kVA and Higher: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.
7. Enclosure: Suitable for service conditions in which transformer is being installed, and in accordance with Section 26 00 00 – Basic Electrical Requirements.

H. Manufacturer, or Equal:

1. **Eaton/Cutler Hammer.**
2. **Square D.**
3. **General Electric.**

## 2.2 PANELBOARDS

- A. Panelboards shall be dead-front and factory-assembled.
- B. Panelboards shall comply with NEMA PB 1, as well as the provisions of UL 67, and shall be UL listed.
- C. Panelboards indicated on Drawings as service equipment shall be UL labeled for such use.
- D. Panelboards shall be rated at nominal voltages shown for number of wires and phases shown on Drawings.
- E. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.
- F. Panelboards shall be suitable for use with 75 degrees C wire at ampacities shown in NFPA 70, and in accordance with UL 486E.
- G. Lugs for termination of conductors shall comply with Section 26 05 83 – Wire & Cable.
- H. Provide space, mountings, and bus connections for future circuit breaker provisions where indicated as "SPACE" on Panelboard Schedules such that like devices may be installed without additional hardware or modification of main bussing.
- I. **Ratings:**



1. Unless indicated otherwise, load current ratings for panelboard assemblies, buses, and circuit breakers are non-continuous as defined by NFPA 70. Provide 100% (continuous) rated equipment only where specifically indicated.
2. Panelboards rated 240 volts ac or less shall have short circuit current ratings not less than 22 kA rms symmetrical.
3. Panelboards rated 480/277 volts ac shall have short circuit current ratings not less than 35 kA rms symmetrical.
4. Panelboards shall be labeled with a UL short circuit current rating. Series ratings are not acceptable.

**J. Construction:**

1. Provide enclosure type in accordance with Section 26 00 00 – Basic Electrical Requirements.
2. Panelboard finish shall be rust-inhibitor prime with ANSI 61 gray, baked enamel coat.
3. Panelboards shall have tin-plated copper phase bussing and terminal bars, full size throughout length of panelboard. Machine, drill, and tap for mounting of current and future devices along entire bus.
4. Panelboards shall have tin-plated copper neutral bussing and terminal bars, full size throughout length of panelboard, where neutral is required. Neutral terminal bus shall be isolated from enclosure, phase, and equipment ground bussing, unless specifically indicated otherwise. Provide number of termination points to match quantity of breaker pole positions.
5. Panelboards shall have tin-plated copper equipment ground bussing and terminal bars, full size throughout length of panelboard. Ground terminal bus shall be bonded to enclosure. Provide number of termination points to match quantity of breaker pole positions.
6. Equip panelboard with all provisions required to install future devices to completely fill the panelboard.
7. Panelboards shall have hinged doors with combination catch and latch.
8. Front panels shall be so arranged that when the plates are removed, the gutters, terminals, and wiring will be exposed and accessible.
9. Doors shall have inner doors within the plates to have only the breaker operating mechanisms exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.
10. Secure panelboards with keyed, door-handle locks, catch- and tumbler-type. All supplied panelboards shall be keyed alike and two milled keys shall be supplied with each panelboard.

11. Panelboards shall have the necessary barriers, supports, and wiring gutters.
12. Trim screws shall be stainless steel.
13. Provide a metal frame with transparent plastic face to insert typewritten circuit directory inside the inner door on each panelboard.

**K. Circuit Breakers:**

1. Provide in accordance with NEMA KS 1, UL 98, and UL 489.
2. Protective devices shall be adapted to panelboard installation.
3. Circuit breakers shall be thermal-magnetic, quick-make, quick-break type, unless indicated otherwise.
4. Provide small-frame molded-case circuit breakers in panelboards rated 480 volts ac.
5. Provide "miniature" circuit breakers in panelboards rated 240 volts or less, except for main circuit breakers, which shall be small-frame molded-case circuit breakers.
6. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units.
7. Provide bolt-on circuit breakers in all panelboards.
8. Breakers shall indicate ON/OFF and TRIPPED positions clearly on or near handle.
9. Interrupt Rating: Not less than 10 kA rms symmetrical for breakers rated 240 volts ac or less, and not less than 14 kA rms symmetrical for breakers rated 480/277 volts ac.
10. Trip Mechanism:
  - a. Thermal and magnetic trip elements in each pole.
  - b. Two- and three-pole breakers shall be common trip.
  - c. Mechanism opens all poles when overcurrent occurs on any single pole.
  - d. Test button on cover.
  - e. Do not substitute single-pole breakers with handle ties for multi-pole breakers.
  - f. Calibrated for 40 degrees C ambient.
11. Do not use tandem or dual circuit breakers in normal single-pole spaces.
12. Furnish provisions for handle padlocking for circuit breakers where indicated.
13. Provide nameplates for each circuit and blank nameplates for spares.

**L. Surge Protection Devices:**

1. Surge protection devices, where indicated, shall be designed to provide transient voltage protection for panelboards. Surge suppressors shall comply with UL 1449 and shall be UL labeled for such use.
2. Provide surge protection devices of types indicated on Drawings, and as defined in UL 1449.
3. Surge protection devices shall be resettable. Surge protection devices with sacrificial element shall not be acceptable.
4. Panelboard surge protection devices shall be **Eaton SPD Series** or equal.

**M. Manufacturer, or Equal:**

1. **Eaton/Cutler Hammer.**
2. **Square D.**
3. **General Electric.**

**PART 3 -- EXECUTION**

**3.1 INSTALLATION**

A. Install in accordance with NECA and manufacturer's instructions.

**B. Transformers:**

1. Load external vibration isolator for transformers such that no direct transformer metal is in direct contact with mounting surface.
2. Provide liquid-tight, flexible metal conduit for electrical connections.
3. Connect voltage taps to modulate actual output voltage under normal system conditions to be as close to rated output voltage as possible.

**C. Panelboards:**

1. Install in accordance with NEMA PB 1.1.
2. Install securely, plumb, in-line, and square with walls.
3. Install top of panelboard 78 inches above floor, unless otherwise shown.
4. Install ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.
5. Install filler plates in unused spaces.
6. Route conductors neatly in groups; bundle and wrap with nylon wire ties.

7. Provide typewritten circuit directory for each panelboard.
8. Provide acrylic nameplate indicating load served for each branch or feeder circuit breaker and affix next to breaker.

### 3.2 TESTS

- A. Perform in accordance with Section 26 01 26 – Electrical Testing.

- END OF SECTION -

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## **SECTION 26 32 16 – OWNER-FURNISHED PROPANE ENGINE STANDBY GENERATORS**

### **PART 1 -- GENERAL**

#### **1.1 RELATED SECTIONS**

- A. Refer to the following sections for other requirements related to this section:

1. Section 26 36 23 – Transfer Switches.

#### **1.2 REFERENCE STANDARDS**

- A. The following is a list of standards which may be referenced in this section:

**Institute of Electrical and Electronics Engineers (IEEE)**

C37.102                      Guide for AC Generator Protection

**National Electrical Contractors Association (NECA)**

404                          Recommended Practices for Installing Generator Sets

**National Electrical Manufacturers Association (NEMA)**

MG 1                        Motors and Generators

**National Fire Protection Agency (NFPA)**

30                            Flammable and Combustible Liquids Code

37                            Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

58                            Liquefied Petroleum Gas Code

110                          Standard for Emergency and Standby Power Systems

#### **1.3 REUSE OF EXISTING EQUIPMENT**

- A. The following existing equipment from the Iron Gate Dam shall be reused as shown for this facility:
1. 100 kW/125 kVA, 240V, 3-phase, 4-wire Liquid Propane Standby Generator, and associated accessories. Included in the Work is reprogramming and rewiring this generator for 480V, 3-phase power.
  2. Pad-mount Propane Tank, including pressure gauges, relief valves, isolation valves, and pressure regulators.
- B. Salvage to OWNER the existing line circuit breaker for the standby generator. Details for the new line circuit breaker are provided herein.
- C. Contractor shall verify that existing equipment is suitable for use prior to installation. Inform OWNER if existing equipment is defective or otherwise unsuitable.

## PART 2 -- PRODUCTS

### 2.1 LINE CIRCUIT BREAKER

- A. A new line circuit breaker shall be supplied to protect the existing standby generator and conductors at 480V, 3-phase. Contractor shall coordinate with local generator supplier to choose an appropriately rated breaker. Rating shown on drawings is anticipated based on conductor sizing.
- B. The circuit breaker shall be installed on the generator skid below the control panel.
- C. The circuit breaker shall be 100% rated and equipped with an adjustable electronic 'LSI' trip sensor unit with the following functions:
  - 1. Adjustable long-time current pickup.
  - 2. Adjustable long-time delay.
  - 3. Adjustable short-time current pickup.
  - 4. Adjustable short-time delay.
  - 5. Adjustable instantaneous trip.
- D. The frame rating of the circuit breaker shall be manufacturer's standard for the generator set supplied.
- E. **Interrupt Rating:** Manufacturer's standard at 480V.

### 2.2 ELECTRICAL CONNECTIONS

- A. Power connections to standby generator set auxiliary devices shall be made at the devices by the installing contractor at the time of installation, with required protection provided by plant distribution panels.

### 2.3 PIPING

- A. CONTRACTOR is responsible for routing piping in-kind between relocated tank and standby generator. Any new piping connections shall be 1 ½" diameter Sch 40 steel pipe, epoxy coated.

### 2.4 CONTROL PANEL

- A. Automatic run controls shall be suitable for remote interface and control by transfer switch. Engine generator set shall start and run upon closure of a remote dry contact provided by transfer switch specified in Section 26 36 23 – Transfer Switches.
- B. **Communications:**
  - 1. Provide accessory from manufacturer for existing control panel to allow use of Ethernet/IP protocol.

C. The following I/O shall be associated with the standby generator:

#	Description	Type	Connected Device
1	Generator Start	Discrete input	Automatic Transfer Switch
	Remote Generator Emergency Stop	E-stop circuit	Facility SCADA
2	Alarms & Status:		
	(a) Running	Ethernet/IP	Facility SCADA
	(b) Trouble	Discrete output	Facility SCADA
	(c) Fault	Discrete output	Facility SCADA
	(d) Low fuel level	Ethernet/IP	Facility SCADA
	(e) Low oil pressure	Ethernet/IP	Facility SCADA
	(f) High oil temperature	Ethernet/IP	Facility SCADA
	(g) Low oil level	Ethernet/IP	Facility SCADA
	(h) High coolant temperature	Ethernet/IP	Facility SCADA
	(i) Low coolant level	Ethernet/IP	Facility SCADA
	(j) High bearing temperature	Ethernet/IP	Facility SCADA
	(l) Over speed	Ethernet/IP	Facility SCADA
	(m) Over cranking	Ethernet/IP	Facility SCADA
	(n) Battery failure	Ethernet/IP	Facility SCADA
	(o) Charger failure	Ethernet/IP	Facility SCADA

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. Level and securely mount engine generator set in accordance with manufacturer's recommendations.
- B. Install in accordance with NECA 404.

### 3.2 PROPANE STORAGE SYSTEM

- A. Installation shall be in accordance with NFPA 37 and manufacturer's instructions for fuel line connection.

### 3.3 FIELD FINISHING

- A. Touch up damaged coating with paint system compatible with existing.



### 3.4 FUNCTIONAL AND PERFORMANCE TESTING

- A. In accordance with Section 26 01 26 – Electrical Testing.
- B. Submit functional test plan to OWNER for approval prior to performing tests.

- END OF SECTION -

## SECTION 26 36 23 - TRANSFER SWITCHES

### PART 1 -- GENERAL

#### 1.1 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

**Institute of Electrical and Electronics Engineers (IEEE)**

C37.90.1                      Standard for Surge Withstand Capability (SWC) Tests  
for Relays and Relay Systems Associated with Electric  
Power Apparatus

**National Electrical Manufacturers Association (NEMA)**

ICS 1                      Industrial Control and Systems: General Requirements

ICS 2                      Industrial Control and Systems Controllers, Contactors  
and Overload Relays Rated 600 Volts

**Underwriters Laboratories Inc. (UL)**

1008                      Transfer Switch Equipment

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

**B. Product Data:**

1. Descriptive product information.
2. Dimensional drawings.
3. Control diagrams, indicating interconnection terminal blocks.
4. Conduit entrance locations.
5. Equipment ratings.
6. Seismic anchorage and bracing drawings and cutsheets.

**C. Technical Manuals:** O&M data shall include the following:

1. Copies of the product data above.
2. Seismic anchorage and bracing calculations.
3. Factory test reports.

## PART 2 -- PRODUCTS

### 2.1 MANUFACTURERS

- A. Kohler.
- B. ASCO.

### 2.2 GENERAL

- A. Provide new transfer switch to be installed for transfer to existing standby generator power. Refer to Section 26 32 16 – Propane Engine Standby Generators for requirements on reuse of the existing generator.
- B. Transfer switches shall be manufactured in accordance with NEMA ICS 1, NEMA ICS 2, IEEE C37.90.1, and UL 1008.
- C. Transfer switch consisting of inherently double-throw power switch unit with interconnected control module.
- D. Rated as shown for total system transfer of motor, heating, lighting, and other loads.
- E. Suitable for 480 volts, three-phase, three-wire, electrical service having an available short circuit current at line terminals of 14 kA rms symmetrical.
- F. **Switch Rating:** As shown on Drawings.
- G. Provide nonautomatic (manual) transfer switch as indicated on Drawings.
- H. Suitable for use with 75 degrees C wire.
- I. **Enclosure:**
  - 1. NEMA type 12 steel construction, with enclosure grounding terminal.
  - 2. Dead front, front accessible wall-mounted cabinet.
  - 3. Continuously hinged single door, with handle and lock cylinder.
  - 4. Finish: Baked enamel applied over rust-inhibiting, phosphated base coating. Provide gray finish.
- J. **Operating Conditions:** Transfer switches to be fully rated at maximum ambient temperature of 104 degrees F.
- K. **Nameplates:** Provide nameplate in accordance with Section 26 00 00 – Basic Electrical Requirements.

### 2.3 TRANSFER SWITCH

- A. Electrically operated, mechanically held, double-throw.

- B. Momentarily energized, single-electrically operated mechanism energized from target transfer source.
- C. Locking mechanism to maintain constant contact pressure.
- D. Mechanical interlock switch to ensure sources are not paralleled.
- E. Main and arcing contacts visible for inspection with cabinet door and barrier covers removed.
- F. Silver alloy main contacts protected by arcing contacts.
- G. Internal operating handle and external control panel to manually transfer in either direction under either loaded or unloaded conditions.
- H. **Power Terminals:** Suitable for number and size of conductors shown on Drawings for each source and load.

## 2.4 CONTROL MODULE

- A. Integral to transfer switch unit with keypad and display flush- or semi-flush-mounted to door.
- B. Microprocessor for sensing and logic control with inherent communications capability.
- C. Backlit LCD display and keypad for viewing and programming transfer switch parameters.
- D. LED indicators for SOURCE AVAILABLE (either direction), NORMAL POSITION, EMERGENCY POSITION, and TRANSFER SWITCH FAULT.
- E. **Programmable functions:**
  - 1. Voltage and frequency pickup and dropout.
  - 2. Time delays.
  - 3. Generator exerciser.
  - 4. Two discrete inputs and two discrete outputs.
- F. **Adjustable Voltage Sensor Ranges:**
  - 1. Pickup: 85 to 100% nominal.
  - 2. Dropout: 75 to 98% of pickup setting.
- G. **Adjustable Frequency Sensor Ranges:**
  - 1. Pickup: 90 to 100% nominal.
  - 2. Dropout: 87 to 89% of pickup setting.
- H. **Adjustable Time Delays:**

1. Engine Starting Contact Actuation: 0 to 5 minute delay.
  2. Load Transfer to Emergency: 0 to 5 minute delay.
  3. Retransfer to Normal: 0 to 30 minute delay.
  4. Unload Running Time: 0 to 30 minute delay.
  5. Controller shall allow bypass of any time delay, for testing and maintenance purposes.
- I. **Engine Start Control:** Form C dry contacts, rated 10A at 24 volts dc and wired to easily accessible terminal blocks.
- J. **Auxiliary Position Indicating Contacts:**
1. Normally open, dry contacts rated 10A at 120 volts ac.
  2. 8 for normal position, 8 for standby position.
- K. **Engine Exerciser:**
1. 30-day clock, adjustable to 15-minute increments.
  2. Allows for automatic exercising of generator without load transfer.
  3. Controller shall allow disabling of automatic exercising, and allow manual start of exerciser sequence.
- L. **Communications:**
1. Control panel shall be equipped with Ethernet/IP protocol. Modbus TCP protocol without Ethernet/IP support will not be acceptable.

## 2.5 FACTORY TESTS

- A. Dielectric strength test in accordance with NEMA ICS 1.
- B. Test operation of individual components, sequence of operation, correct transfer times, correct voltage and frequency, and time delay settings.

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure enclosure to wall surface using structural steel channels and anchor bolts of sufficient size and number adequate for site seismic conditions.

### 3.2 FIELD TESTING

- A. In accordance with Section 26 01 26 – Electrical Testing.

- END OF SECTION -

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## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **California Code of Regulations (CCOR)**

Title 24 – California Building Standards Code

##### **Illuminating Engineering Society of North America (IESNA)**

LM-79 IES Electrical and Photometric Measurements of Solid-State Lighting Products

LM-80 IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources

TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources

##### **National Electrical Manufacturers Association (NEMA)**

ICS 6 Industrial Control and Systems: Enclosures

##### **Underwriters Laboratories Inc. (UL)**

1598 Luminaires

2108 Low Voltage Lighting Systems

8750 Light Emitting Diode (LED) Equipment for Use in Lighting Products

##### **U.S. Environmental Protection Agency and U.S. Department of Energy**

Energy Star

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Sections 01 33 00 - Contractor Submittals, and 26 00 00 – Basic Electrical Requirements.

B. **Product Data:**

1. Exterior luminaires:
  - a. Catalog data sheets and pictures.
  - b. Luminaire finish and metal gauge.
  - c. Lens material, pattern, and thickness.
  - d. Color temperature.



- e. Voltages.
  - f. Approximate life (in hours).
  - g. Lumen output chart.
  - h. Color Rendering Index (CRI).
  - i. IES lighting classification and isolux diagram.
  - j. Fastening details to wall or pole
  - k. For light poles, submit wind loading, complete dimensions, and finish
2. Light Emitting Diode (LED) fixtures:
- a. Rated life.
  - b. Operating temperature range.
  - c. Warranty on light engine and driver.
  - d. Power factor.
  - e. IESNA LM-80 test reports.
  - f. IESNA TM-21 ratings.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

- A. Specific requirements relative to execution of WORK of this section are located on the Drawings.
- B. Provide luminaires that are labeled by UL or another approved testing agency.
- C. Provide products that have been in satisfactory industrial use for at least 2 years.
- D. Feed-through type or separate junction box.
- E. **Wire Leads:** Minimum 18 AWG.
- F. **Component Access:** Accessible and replaceable without removing luminaire from ceiling.
- G. **Exterior Installations:**
  - 1. UL Labeled: SUITABLE FOR WET LOCATIONS.
  - 2. When factory-installed photocells are provided, entire assembly shall have UL label.

## 2.2 LED FIXTURES

- A. Provide materials and equipment of manufacturers regularly engaged in the production of LED fixtures.
- B. Provide Energy Star compliance for solid state luminaires.
- C. Provide RoHS compliant LED light sources and drivers.
- D. **Warranty:** 5 years minimum.

### E. **Light Engine:**

- 1. All components on a single plate with quick-disconnect plugs.
- 2. Provide thermal protection and heat sink.
- 3. Provide a surge protection device in accordance with IEEE C62.41.2.
- 4. Light Engine Rating: 100,000 hours at 25 degrees C, L70.
- 5. Color Temperature:
  - a. Indoor: 4000K.
  - b. Outdoor: 5000K.
- 6. CRI: Minimum of 70.

### F. **Drivers:**

- 1. Expected life of 100,000 hours at 25 degrees C.
- 2. Operating Voltage Range: 120V to 277V, 60 Hz, unless noted otherwise, with sustained variations of plus or minus 10 percent without damaging the driver.
- 3. Power Factor: 90% or greater.

## 2.3 POLES

- A. **Wind Rating (with Luminaire):** 100 mph steady winds, without incurred damage.
- B. **Material:** As specified on Drawings.
- C. **Type:**
  - 1. As specified on Drawings.
  - 2. Hinged type for structure-mount and rail-mount poles. Hinged at mid-point by use of a stainless steel hinge pin.
- D. Hardware and pole-mounting kits included with poles.

- E. Provide mounting kits for luminaires that are compatible with the luminaire mounting type.

### **PART 3 -- EXECUTION**

#### **3.1 LUMINAIRES**

- A. Install in accordance with manufacturer's recommendations.
- B. Coordinate mounting, fastening, and environmental conditions with Section 26 00 00 – Basic Electrical Requirements.
- C. Install plumb and level.
- D. **Supports for Hinge-Type Poles:** Provide hardware for mounting to railing and/or concrete structure.
- E. Locate poles to avoid conflict with other systems and blockage of luminaire light output.

#### **3.2 CLEANING FOLLOWING CONSTRUCTION**

- A. Remove labels and other markings, except UL listing mark.
- B. Wipe luminaires inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.
- D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

- END OF SECTION -

## **SECTION 31 00 00 - EARTHWORK**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. The CONTRACTOR shall submit samples of materials proposed for the WORK in conformance with the requirements of Section 01 33 00 – Contractor Submittals. Sample sizes shall be as determined by the testing laboratory
- B. CONTRACTOR's Detailed Excavation Plan
  - 1. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or deeper, shall submit to the OWNER and shall be in receipt of the OWNER's written acceptance of the CONTRACTOR's detailed plan showing the design of shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation.
  - 2. The CONTRACTOR's plan shall be prepared and signed and sealed by a Professional Engineer experienced in the field of geotechnical engineering and licensed in the State where the WORK is being performed.
  - 3. The OWNER's acceptance of said plan will be for verification of submittal of the plan according to this requirement.
  - 4. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California.
- C. The CONTRACTOR shall submit certification to the ENGINEER that the chloride concentration in imported materials within the pipe zone does not exceed 100 ppm, when tested in accordance with the requirements of AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.
- D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal.

### **PART 2 -- PRODUCTS**

#### **2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS**

- A. **General**

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.
2. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

**B. Suitable Materials**

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.
2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.
4. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.
5. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

**C. Types of Suitable Materials.** The following types of suitable materials are defined:

**Type AS (Aggregate Subbase):** Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. This material is often specified and required underneath the base course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 3-inch maximum size or 2-inch maximum size gradation shall be used, unless specifically indicated. The sand equivalent value shall be greater than 20. Crushed rock aggregate subbase material shall meet one of the following gradation requirements, as shown on the Drawings or approved by the OWNER:

Sieve Size	Percentage Passing (3-inch Max)	Percentage Passing (2-inch Max)
3-inch	100	100
2.0 inch	90 - 100	100
1.5 inch	-	95 - 100
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40

No. 200	0 - 20	0 - 20
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As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** – Class 1 aggregate subbase material.

**Type C (Civil Fill) (Not for use beneath concrete foundations):** Civil Fill may consist of imported materials or natural on-site materials. Civil Fill may be a combination of Type AS material, Type GF, or Type SF material, or any mixture thereof, except as shown. Some mixing, removal of oversized particles (greater than 4-inch diameter) and/or removal of other unsuitable material may be required. As identified in the GDR, on site sources of this material may consist of existing road base and channel alluvium. The colluvium deposits, consisting of cobbles and boulders within a fat clay matrix, shall not be considered acceptable sources of civil fill material.

**Type CLSM (Controlled Low Strength Material):** Controlled low strength material (CLSM) shall be in accordance with Section 31 23 00 - Controlled Low Strength Material.

**Type DRC (Drain-rock Coarse):** Crushed rock or gravel meeting the following gradation requirements.

Sieve Size	Percentage Passing
2-inch	100
1.5-inch	90 - 100
1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** - Class-1B Permeable material.

**Type DRG (Drain-rock Graded):** Drain-rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The drain-rock shall have a sand equivalent value greater than 75. The finish graded surface of the drain-rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
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1-inch	100
0.75-inch	90 – 100
0.375-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15
No. 50	0 – 7
No. 200	0 – 3

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** - Class-2 Permeable material.

The finish graded surface of the drain-rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs.

**Type EF (Embankment Fills from on-site materials):** Embankment Fill for the intake grading portion of the project may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported materials comprised of mixtures of Type AS, Type DRG, Type GF, or Type SF material. If on-site material is used for embankments, it may require moisture conditioning to facilitate compaction. Drying of the embankment fill material may not be practical during cold or wet periods of the year. Acceptable embankment material shall meet or exceed the compaction density of 95 percent as determined by ASTM D-1557.

**Type GF (Granular Fill 0.75-inch minus):** Angular crushed rock, stone or gravel, and sand conforming to the requirements listed below. Do not use pea gravel as granular backfill. The material shall have a maximum liquid limit of 35 and a maximum plasticity index of 10. The material shall have a sand equivalent value greater than 75. (This material is also known as Class I crushed stone.)

Sieve Size	Percentage Passing
0.75-inch	100
No. 4	30 - 50
No. 200	0 - 6

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans**- Class-2 ¾" max. aggregate base material, provided the liquid limit and plasticity index requirements above are met.

**Type SF (Structural Fill / Foundation Base):** Crushed rock structural fill material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for fill material required beneath concrete foundations. This material is often specified and required directly underneath the finish course of asphaltic or concrete pavement. At the option of the CONTRACTOR, the grading for either the 1.5-inch maximum size or 0.75-inch maximum size gradation may be used for material beneath concrete foundations, unless specifically indicated. The sand equivalent value shall be greater than 22. The material shall meet the following gradation requirements:

Sieve Size	Percentage Passing	
	1.5-inch Max Gradation	0.75-inch Max Gradation
2-inch	100	-
1.5-inch	90 - 100	-
1-inch	-	100
0.75-inch	81 - 91	90 – 100
No. 4	43 - 53	55 – 67
No. 16	23 - 29	28 – 38
No. 200	4 - 10	4 – 10

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans**- Class-2 aggregate base material, either the 1.5-inch maximum size gradation or the 0.75-inch maximum size gradation, unless specifically indicated.

**Type SNF (Sand Fill):** Sand material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
0.375-inch	100
No. 4	90 - 100
No. 16	50 - 80
No. 50	5 - 25



No. 200	0 - 5
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**Type T (Topsoil):** Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

**Schedule:** Earth materials shall be as indicated in the Contract Drawings. Where clear definition in the drawings is not defined, the following schedule may be used to define acceptable fill materials.

Civil Work Area	Material Type
Embankment Fills – (Intake grading and other Embankments)	EF
Pipe Zone (unless indicated as Trench Zone or Bedding)	
Pipe Bedding	SNF
Uncoated DIP	GF
Small PVC (< 6-inch dia.), HDPE (ADS) Drainpipe, & other pipes < 3-inch dia.	GF, SNF
Other PVC, VCP, HDPE Pipe	GF
Trench zone backfill except as identified below	C, EF or an approved mixture thereof.
Final backfill for areas outside of gravel roadways	T
Trench zone and final backfill under structures	Same as pipe zone except where concrete encasement is required
Replace pipeline trench over-excavation	DRC with non-woven filter fabric, or same as pipe zone backfill if trench is above water table.
Gravel Road base materials	GF
Gravel Road subbase materials	AS
Backfill around structures (including berms)	C, EF, or an approved mixture
Under hydraulic or water retaining structures with underdrains	DRG

Civil Work Area	Material Type
Under structures where ground water is removed to allow placement of concrete	DRC, underlain by non-woven filter fabric
Under all other structures	SF
Top 6-inches of embankment fills or backfills around structures	T

#### D. Unsuitable Materials

1. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of PT, OH, CH, MH, or OL shall be classified as unsuitable materials.
2. In addition to the materials identified as unsuitable in the description above, a material shall be classified as unsuitable if one of the following conditions is present;
  - a. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.
  - b. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

### 2.2 MATERIALS TESTING

#### A. Samples

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR's expense.
2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. **Particle Size Analysis.** Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. **Sand Equivalent Value.** Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

#### D. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.
- E. Testing for sulfate, resistivity, and pH shall be performed in accordance with California Test Methods 532 and 643 of the California Department of Transportation.
- F. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

### 2.3 IDENTIFICATION TAPE

- A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.
- B. Identification tape shall be 6-inches wide, blue in color, composed of polyethylene, and provided with an integral metallic wire.
- C. Tape shall be labeled with CAUTION – WATER LINE BELOW or similar, as approved by the ENGINEER.

### 2.4 SOIL STERILANT

- A. Soil sterilant or chemical weed control agent shall be a commercial product manufactured specifically to sterilize the subgrade soil against the growth of weeds, plants, or any type of vegetation.

## **PART 3 -- EXECUTION**

### 3.1 EXCAVATION AND BACKFILLING - GENERAL

- A. General
  1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions that would interfere with the proper execution and completion of the WORK.
  2. The removal of such materials shall conform to the lines and grades indicated or ordered.
  3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.
  4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.
  5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).
  6. The CONTRACTOR shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.

7. Surveys shall be performed prior to beginning WORK and upon completion by a surveyor licensed in the state of California.

**B. Removal and Exclusion of Water**

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavations.
2. Dewatering wells, wellpoints, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation WORK begins at each location.
3. Water shall be removed and excluded until backfilling is complete and field soils testing has been completed.

**3.2 OVER-EXCAVATION**

**A. Indicated**

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

**B. Not Indicated**

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

**C. Neither Indicated nor Ordered**

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

**3.3 EXCAVATION IN VICINITY OF TREES**

- A. All trees within the footprint of grading operations and/or concrete construction as indicated shall be removed. Elsewhere trees shall be protected from injury during construction operations.
- B. Protected trees shall be supported during excavation by any means previously reviewed and accepted by the ENGINEER.

**3.4 ROCK EXCAVATION**

- A. **Normal Excavation.** Nearly all excavation, except where indicated in the Contract Drawings shall be considered normal excavation, and may be accomplished using conventional equipment as follows:
  1. For general excavation, a D-9R Caterpillar tractor with a single shank ripper, or equivalent equipment, is considered conventional equipment, if it can rip at a production rate of at least 300 bank cubic yards per hour.

2. For trench excavation, a 235C Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment, is considered conventional equipment, if it can excavate at a production rate of at least 30 bank cubic yards per hour.
3. If material is encountered which the CONTRACTOR believes cannot be excavated by conventional equipment, the ENGINEER shall be notified immediately. The CONTRACTOR shall provide performance tests of the specified conventional or equivalent equipment. If the ENGINEER confirms in writing that the conventional equipment cannot perform at the production rates indicated, the excavation will be considered rock excavation.

**B. Rock Excavation.** Rock excavation shall include removal and disposal of the following items:

1. Boulders measuring 1/3 of a cubic yard or more in volume;
2. Rock material in ledges, bedding deposits, and un-stratified masses that cannot be removed using conventional equipment as defined herein and which require systematic drilling and blasting for removal;
3. Concrete or masonry structures that have been abandoned; and,
4. Conglomerate deposits that are so firmly cemented that they possess the characteristics of solid rock and cannot be removed using conventional equipment as herein defined and require systematic drilling and blasting for removal.

**C. Scope and Payment for Rock Excavation**

1. Rock excavation shall be performed by the CONTRACTOR, provided that if the quantity of rock excavation is affected by any change in the scope of the WORK an appropriate adjustment of the Contract Price will be made. Payment for rock excavation shall be as set forth in the Bid form as a unit price item. If a unit price item for rock excavation is not provided in the Bid form, the extra cost for excavation of rock will be treated as a change.
2. Otherwise, payment will be made in accordance with a negotiated price.

**D. Explosives and Blasting.** Blasting will be permitted on the project site, but will not be permitted within 100 feet of the existing dams or intake structures at the site.

**3.5 DISPOSAL OF EXCESS EXCAVATED MATERIAL**

- A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.
- B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.
- C. The CONTRACTOR shall remove and dispose of excess excavated material at a location selected by the CONTRACTOR and as approved by the ENGINEER or at an off-Site location selected and arranged for by the CONTRACTOR.

- D. The CONTRACTOR shall obtain required permits and landowner and agency approvals for disposal of excess excavated material on-Site or off-Site and shall submit copies of related documents to the ENGINEER for information prior to disposal. CONTRACTOR shall pay costs associated with the removal and disposal.

### 3.6 BACKFILL

#### A. General

1. Backfill shall not be dropped directly upon any structure or pipe.
2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.
3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

#### B. Pre-Placement Conditions

1. Except for drain rock materials being placed in over-excavated areas or trenches, backfill shall not be placed until water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction
2. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.
3. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

#### C. Layering

1. Backfill materials shall be placed and spread evenly in layers. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.
2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

#### D. Moisture Content

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.
2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

### 3.7 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

#### A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 18 inches below the bottom of the footing or 6 inches below the bottom of the slab and brought back to grade with compacted materials acceptable for placement beneath structures.
2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.
3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.
4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.
5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.
6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density as per these specifications.

#### B. Excavation Beneath Concrete Reservoirs

1. Excavation under reservoirs shall extend to the bottom of the drain rock layer.
2. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to 95 percent of maximum density and then graded to provide a reasonably smooth surface for placement of the drain rock.
3. Areas under the reservoir upon which fill, not drain rock, is to be placed, shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain 95 percent of maximum density.

#### C. Excavation Beneath Gravel Roadway Areas

1. Excavation under gravel roadway areas shall extend to the bottom of the aggregate subbase.
2. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.
3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished roadway surfacing.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

**D. Notification of ENGINEER**

1. The CONTRACTOR shall notify the ENGINEER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

**E. Compaction of Fill, Backfill, and Embankment Materials**

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.
2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.
3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

**F. Heavy Equipment**

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.
2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

**G. Layering**

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.
2. Each layer shall be moistened and aerated as necessary.
3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.
4. The embankment and fill shall be compacted in conformance with Paragraph I, below.

**H. Embankments and Fills on Slopes**

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.



2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.
3. Material thus cut shall be re-compacted along with the new material.
4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

**I. Compaction Requirements**

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

<b>Location or Use of Fill or Backfill</b>	<b>Percentage of Maximum Dry Density</b>	<b>Percentage of Relative Density</b>
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath roadway areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

**3.8 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL**

**A. General**

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

**B. Trench Bottom**

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.
2. Excavations for pipe bells and welding shall be made as required.

3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

#### **C. Open Trenches**

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.
2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.
3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

#### **D. Embankments, Fills and Structural Backfills**

1. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.
2. Upon completion of the embankment or structural backfill, a trench conforming to the appropriate detail may be excavated and the pipe may be installed.

#### **E. Trench Shield**

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.
2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.
3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.
4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

#### **F. Placing and Spreading of Backfill Materials**

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory

compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of one-half the diameter of the pipe; or 24 inches, measured in the uncompacted state.
3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24 inches or not.
4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.
5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.
6. The material shall be placed in lifts that will not exceed 6 inches when compacted to the required density.

#### G. **Mechanical Compaction**

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.
2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

#### H. **Pipe And Utility Trench Backfill**

1. Definitions
  - a. **Bedding.** The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.
  - b. **Pipe Zone.** The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.
  - c. **Trench Zone.** The trench zone (located above the pipe zone) is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.
  - d. **Final Backfill.** Final backfill is defined as backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under a roadway, backfill within 18 inches of the roadway subgrade.

## 2. Pipe Zone Backfill

### a. Final Trim

- 1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.
- 2) Excavation for pipe bells and welding shall be made as required.

### b. The pipe zone shall be backfilled with the indicated backfill material.

### c. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

### d. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

## 3. Trench Zone Backfill

### a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

## 4. Final Backfill

### a. Where pipe trench is located under roadway areas, final backfill shall be placed and compacted according to Paragraph K, below, and sloped according to the final grade of the road base material.

### b. Where pipe trench is located in yard areas, outside of the road surfacing, final backfill shall be placed to within 6 inches of the final grade and topped with topsoil. Topsoil shall be reseeded with native grasses in accordance with the Contract Drawings and Specification 31 35 30.

## I. Identification Tape

### 1. Install identification tape as indicated.

### 2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

### 3. The termination box shall be covered with a cast iron lid.

### 4. The box shall be located at grade in road surfacing areas or 6 inches above grade in yard areas.

## J. Trench Shield

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.
2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

#### K. Compaction Requirements

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	90	70
Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	90	70
Pipe zone backfill portion above embedment for flexible pipe	90	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	40
Final backfill, beneath landscape areas	85	40
Trench zone backfill, beneath road surfacing areas, including trench plugs.	90	70
Trench zone backfill, beneath structures, including trench plugs.	95	70
Trench zone backfill, not beneath road surfacing areas or structures,	90	40

including trench plugs.		
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### 3.9 FIELD TESTING

#### A. General:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the OWNER's expense, except as indicated below.

#### B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.
2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.
3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

#### C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.
2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

#### D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.
2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.
3. Lawn areas destroyed by test trenching and excavation shall be regraded and reseeded with natural grass mix in accordance with Section 31 35 30.

- END OF SECTION -

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## SECTION 31 05 19 - GEOTEXTILES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.
- B. **Definitions:** The following definitions apply to the WORK of this Section:
1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
  2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.
  3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.
  4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.
  5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
  6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.
  7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.
  8. Nonwoven geotextile: A geotextile fabric composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern.

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

- A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method



ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sandpaper/Sliding Block Method)

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings
  - 1. Manufacturer material specifications and product literature.
  - 2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
  - 3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
- C. Certifications
  - 1. Certification from geotextile manufacturer that products satisfy the indicated requirements.
  - 2. Field seam efficiency test results.

## PART 2 -- PRODUCTS

### 2.1 WOVEN GEOTEXTILE

- A. Woven geotextile shall be composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.
- B. Polymeric yarn shall be long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.
- C. **Sheet Edges:** Selvaged or finished to prevent outer material from separating from sheet.
- D. Unseamed Sheet Width: Minimum 6 feet.

- E. Nominal Weight per Square Yard: 6 ounces.
- F. Physical Properties: Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR WOVEN GEOTEXTILE		
Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 40 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	0.02 sec. <sup>-1</sup> , MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	4 gpm/sq. ft, MinARV	
Wide Width Strip Tensile Strength	250 lb./in.-width, MinARV	ASTM D 4595
Wide Width Strip Elongation	15 percent, MaxARV	
Trapezoidal Tear Strength	90 lb., MinARV	ASTM D 4533
Puncture Strength	100 lb., MinARV	ASTM D 4833
Abrasion Resistance	5 to 25 percent loss, 250 cycles, MaxARV	ASTM D 4886
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D 4355

## 2.2 NONWOVEN GEOTEXTILE

- A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.
- B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.
- C. **Geotextile Edges:** Selvaged or finished to prevent outer material from separating from sheet.
- D. **Unseamed Sheet Width:** Minimum 6-feet.

E. **Nominal Weight per Square Yard:** 12 ounces.

F. **Physical Properties:** Non-woven geotextiles shall be of the nominal weight per square yard as indicated on the Contract Drawings. Physical properties are will be unique to the weight designation of the geotextile, and are summarized in the following sections. Where no nominal weight is indicated, it shall be assumed that the 12 ounce specifications apply.

1. **Nominal Weight per square yard: 12 ounces**

<b>PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE (12 ounces)</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Apparent Opening Size (AOS)	No. 70 to No. 100 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	0.8 sec. <sup>-1</sup> , MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	65 gpm/sq. ft, MinARV	
Grab Tensile Strength	300 lb MinARV	ASTM D 4632
Elongation at Break	50 percent	ASTM D 4632
Trapezoidal Tear Strength	115 lb., MinARV	ASTM D 4533
Puncture Strength	175 lb., MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2. **Nominal Weight per square yard: 8 ounces**

<b>PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE (8 ounces)</b>		
<b>Property</b>	<b>Requirement</b>	<b>Test Method</b>
Apparent Opening Size (AOS)	No. 70 to No. 100 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.4 sec. <sup>-1</sup> , MinARV	ASTM D 4491

Vertical Waterflow Rate	95 gpm/sq. ft, MinARV	(Falling Head)
Grab Tensile Strength	205 lb MinARV	ASTM D 4632
Elongation at Break	50 percent	ASTM D 4632
Trapezoidal Tear Strength	80 lb., MinARV	ASTM D 4533
Puncture Strength	130 lb., MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	70 to 90 percent strength retention, MinARV after 500 hours	ASTM D 4355

### 2.3 SEWING THREAD

- A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

### 2.4 SECURING PINS

- A. Securing pins shall be steel rods or bars conforming to the following:
  - 1. 3/16-inch diameter.
  - 2. Pointed at one end; head on other end, sufficiently large to retain washer.
  - 3. Minimum Length: 12-inches.
- B. Steel washers for securing pins shall be:
  - 1. Outside Diameter: Not less than 1-1/2 inches.
  - 2. Inside Diameter: 1/4-inch.
  - 3. Thickness: 1/8-inch.
- C. Steel Wire Staples
  - 1. U-shaped.
  - 2. 10-gauge.
  - 3. Minimum 6-inches long.

## **PART 3 -- EXECUTION**

### **3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.
- B. Handle products in manner that maintains undamaged condition.
- C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

### **3.2 LAYING GEOTEXTILE**

- A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.
- B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

### **3.3 ORIENTATION ON SLOPES**

- A. Orient geotextile with long dimension of each sheet parallel to direction of slope.
- B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

### **3.4 JOINTS**

- A. Unseamed Joints
  - 1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:
    - a. Foundation/Subgrade Stabilization: Minimum 18-inches.
    - b. Riprap: Minimum 18-inches.
    - c. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.
    - d. Other Applications: Minimum 12-inches.
- B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.
  - 1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.

2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.
3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.
4. Stitch Type: Double-thread chain stitch, Type 401, Federal Standard No. 751a.
5. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary, to develop required seam strength.
6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

### 3.5 SECURING GEOTEXTILE

- A. Secure geotextile during installation as necessary with sandbags or other means approved by ENGINEER.

- B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.
2. Spacing

<b>Slope</b>	<b>Maximum Pin Spacing, feet</b>
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
4. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

### 3.6 PLACING PRODUCTS OVER GEOTEXTILE

- A. Notify ENGINEER before placing material over geotextile. Do not cover installed geotextile prior to receiving authorization from the ENGINEER to proceed.
- B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

### 3.7 INSTALLING GEOTEXTILE IN TRENCHES

- A. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.
- B. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

### 3.8 RIPRAP APPLICATIONS

- A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.
- B. Sew joints where wave runup may occur.

### 3.9 REPAIRING GEOTEXTILE

- A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

### 3.10 REPLACING CONTAMINATED GEOTEXTILE

- A. Protect geotextile from contamination that would interfere, in ENGINEER's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

- END OF SECTION -

## SECTION 31 05 20 - GEOMEMBRANES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide geomembranes, complete and in place, in accordance with the Contract Documents.
- B. **Definitions:** The following definitions apply to the WORK of this Section:
  - 1. Bridging: The condition when Geomembrane becomes suspended over its subgrade due to contraction of the material or poor installation.
  - 2. Factory Seam: Thermal fusion welding completed at the factory by the product manufacturer.
  - 3. Field Seam: Hot air welded, or a wedge welded seam used to bond factory-fabricated panels together in the field.
  - 4. Fishmouth: An opening resulting from the uneven mating of two Geomembranes where the upper sheet has excessive length that prevents it from being bonded flat to the lower sheet.
  - 5. FTMS: Federal Test Method Standard
  - 6. Geomembrane: An essentially impermeable synthetic membrane used as a solid or liquid barrier.
  - 7. MD: Machine Direction
  - 8. RPP: Reinforced Polypropylene Membrane
  - 9. Subgrade: The soil or geosynthetic surface on which the Geomembrane lies.
  - 10. TD: Transverse Direction
  - 11. Panel: The unit area of Geomembrane that will be seamed in the field. If the Geomembrane is not fabricated into panels in a factory, a panel is identified as a roll or portion of a roll without any seams.

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

- A. The following standards are referenced in this Section:

ASTM D 413	Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate
ASTM D 751	Standard Test Methods for Coated Fabrics



ASTM D 1149	Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment
ASTM D 1204	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 2136	Standard Test Method for Coated Fabrics—Low-Temperature Bend Test
ASTM D 3083	Specification For Flexible Poly (Vinyl Chloride) Plastic Sheeting For Pond, Canal, And Reservoir Lining
ASTM D 3884	Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
ASTM D 4885	Standard Test Method for Determining Performance Strength of Geomembranes by the Wide Strip Tensile Method
ASTM G 155	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
FTMS 101C, M2031	Puncture Resistance

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings. Submit 30 days prior to deployment.
  - 1. Manufacturer material specifications and product literature.
  - 2. The fabricator shall furnish a proposed geomembrane panel layout to be approved in writing by the ENGINEER prior to material shipment. The drawings shall show: the direction of factory seams, the size of panels, the location of field seams, and the location and details of penetrations, consistent with the requirements of the project drawing. These details shall include the recommended termination details of the geomembrane.
- C. Certifications and Test Reports. Submit 30 days prior to deployment.
  - 1. Prior to installation of the panels, the fabricator shall provide the OWNER's representative with written certification that the factory seams were inspected in accordance with these specifications.
- D. Qualifications. Submit 30 days prior to deployment.
  - 1. Submit a list of at least ten facilities completed by installer. (For each installation, provide the name of facility, location, date of installation, type and thickness of geomembrane used and surface area of the installed geomembrane.)

2. Submit resumes or qualifications of the installation supervisor, master seamer and Technicians assigned to this project. The installer of the proposed RPP geomembrane shall have a minimum of one million square feet of RPP fabrication experience.
  3. Installer's Quality Control Program
  4. Manufacturers qualifications: The manufacturer of the RPP geomembrane of the type specified shall have at least five years of experience in the manufacture of RPP geomembranes. In addition, the geomembrane manufacturer shall have manufactured at least one million square feet of the specified type of geomembrane in the last five years.
- E. Warranties.
1. Submit a copy of all material warranties.
  2. Submit a copy of all liner installation warranties.
- F. Additional Submittals (Provided during and upon completion of Construction):
1. Daily written acceptance of sub-grade surface
  2. Low-temperature seaming procedures if applicable
  3. Prequalification test seam samples
  4. Field seam non-destructive test results
  5. Field seam destructive test results
  6. Daily field installation reports
  7. Installation record drawing

## **PART 2 -- PRODUCTS**

### **2.1 GEOMEMBRANE:**

- A. The geomembrane roll stock shall be manufactured by the extrusion calendaring process, consisting of first quality ingredients, suitably compounded with sufficient additives to ensure long-term durability.
- B. The finished membrane shall be uniform in color, thickness, size and surface texture. The finished membrane shall consist of two (2) plies of polypropylene laminated over one (1) ply of reinforcing scrim.
- C. The scrim shall be fully encapsulated with the encapsulation extending a minimum of 1/8" beyond the scrim edges. Exposed fabric along the length of the roll stock shall not be permitted.

D. The geomembrane material shall be 45 mil scrim-reinforced Polypropylene (RPP) with the following physical specifications:

1. Thickness: 45 mil (+/- 10%) (ASTM D751)
2. Breaking Strength:

Warp (MD)	300 lbs	(ASTM D751, Method A)
Fill (TD)	250 lbs	(ASTM D751, Method A)
3. Tear Strength:

Warp (MD)	70 lbs	(ASTM D751, Method B, mod)
Fill (TD)	70 lbs	(ASTM D751, Method B, mod)
4. Wide Width Strength:

Warp (MD)	150 lbs	(ASTM D4885)
Fill (TD)	125 lbs	(ASTM D4885)
5. Low Temperature: -40 F (ASTM D2136; 1/8" Mandrel, 4hr)
6. Dimension Stability: 1% max (ASTM D1204)
7. Hydrostatic Resistance: 350 psi (ASTM D1204)
8. Ply Adhesion: 40 lbs/in<sup>2</sup> (ASTM D751 mod)
9. Puncture Resistance: 300 lbs (FTMS 101C, Method 2031)
10. Abrasion Resistance: 7,500 cycles (ASTM D3884; H18 / 1kg)
11. Stress Crack Resistance: 3,000 hrs (ASTM D1693)
12. UV Resistance: 35,000 hrs (ASTM G154)
13. Ozone Resistance: No Cracks (ASTM D1149; 100 pphm / 14 days)

## 2.2 FACTORY SEAMS:

- A. The RPP roll stock shall be factory fabricated into the largest panels possible to minimize field seams. Field fabrication will not be allowed. Prior to factory seaming, all roll goods shall be inspected. All factory seams shall be made by thermal fusion methods. All factory seams shall have a minimum scrim-to-scrim overlap of one and one-half inches (1.5") when fabricated. Fabricated seams found to have less than the specified minimum overlap shall be repaired by adding an overlap or cap strip that provides the minimum specified overlap or it will be rejected. All seams shall be made so that thermal fusion bond extends fully along the width of the sheet so that no loose edges are present.

B. Factory Seams Shall have the Following Properties:

1. Bonded Seam Strength: 200 lb min (ASTM D751)
2. Peel Adhesion: 20 lbs/in (ASTM D413)

C. Inspection and testing of Factory Seams:

1. All sheets and seams shall be 100% visually inspected during fabrication. No defective seams or exposed scrim will be allowed. Upon discovery of any defective seam, production shall stop and the seam shall be repaired. Production personnel shall determine and rectify the cause of the defect prior to continuation of the seaming process. All exposed scrim edges shall be sealed with an approved polypropylene edge caulk, capped with a strip of polypropylene or extrusion welded. All indicated repairs shall be made before the panels are packaged for shipment.
2. In addition to visual inspection, a 48-inch weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Sample shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut at quarter points from each 48-inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. The peel adhesion shall be tested in accordance with ASTM D413 as modified in Annex A of ANSI/NSF 54.
3. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. Test results shall be provided to the ENGINEER upon request.

2.3 LINER BOOT

- A. Liner boots for pipes shall be fabricated to the outer dimension of the pipe and the liner slope, as indicated, and shall have the same material properties as the liner to which the boot will be attached.
- B. Liner boots shall be supplied by the same manufacturer as the liner panels, and shall be installed by a qualified liner installer, per the liner installer qualification requirements enlisted above.

2.4 PANEL PACKAGING AND STORAGE

- A. Each factory-fabricated panel shall be accordion-folded and placed onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each panel shall be given prominent and unique identifying markings indicating the proper direction of unfolding to facilitate layout and position in the field. The panels shall be suitably packaged, enclosed, and protected to prevent damage during shipment and each package shall be prominently marked in the same fashion as the panels within. Until needed, packaged factory fabricated panels shall be stored in their original unopened

wrapping, and protected from the direct heat of the sun, where possible. Pallets should not be stacked.

## **PART 3 -- EXECUTION**

### **3.1 SUBGRADE PREPARATION**

- A. The surfaces on which the lining is to be placed shall be maintained in a firm, clean, moist and smooth condition during the lining installation.
- B. All surfaces shall be compacted and smooth graded with anchor trenches provided as required and detailed. The subgrade shall be compacted in accordance with Section – 31 00 00 Earthwork.
- C. All surfaces to be lined shall be free of rocks, roots, gravel, grade stakes or debris that may puncture the geomembrane.
- D. An 8 oz non-woven geotextile shall be used as a cushioning agent under the RPP geomembrane.
- E. Handle products in manner that maintains undamaged condition.
- F. Do not store products directly on ground. Ship and store geotextile, if allowed, with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.
- G. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane.
- H. Immediately prior to the installation of the geomembrane, the ENGINEER and the geomembrane installer shall perform a complete and detailed inspection to determine acceptance of the finished subgrade and elevations. Any erosion or other damage to the subgrade that has occurred shall be corrected before geomembrane placement.

### **3.2 GEOMEMBRANE PLACEMENT**

- A. RPP geomembrane shall not be deployed until all applicable submittals and certifications listed in this specification are submitted and approved by the ENGINEER. Should the RPP geomembrane be deployed prior to approval of the ENGINEER, it will be at the sole risk of the geomembrane installer and/or CONTRACTOR. If the material does not meet the specification it shall be removed from the site at no cost to the OWNER.
- B. Only those panels of lining material that can be anchored and seamed together the same day shall be unpackaged and placed into position. In areas where high wind is prevalent, the lining installation should begin on the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags sufficient to hold it down during high winds. The leading edges of the liner material left exposed after the day's work shall be anchored with sand bags spaced no less than 10 feet to prevent damage or displacement due to wind.

- C. The geomembrane shall be placed over the prepared surfaces in such a manner as to insure minimum handling and in accordance with the approved shop drawings. The geomembrane shall be closely fitted and sealed around all inlets, outlets, and other projections through the lining, using prefabricated pipe boots as shown in the construction details. Liner panels, damaged from any cause, shall be repaired in accordance with Section 3.3 – Field Seams.
- D. Geomembrane placement shall not be performed if subgrade or bedding moisture content prevents proper subgrade preparation, panel placement or panel seaming.
- E. The geomembrane shall not be allowed to “bridgeover” voids or low areas in the subgrade. In these areas the RPP geomembrane shall be installed with sufficient slack as to allow material to remain in intimate contact with the subgrade or the subgrade repaired.
- F. In general, field seams shall be oriented parallel to the line of the maximum slope, i.e., the seam should run down the slope. In corners and odd geometric locations, the total length of the field seam shall be minimized. If at all possible, seams shall not be located at low points in the subgrade unless geometry requires seaming to be done at these locations.
- G. No vehicles will be allowed on the geomembrane. Small rubber tired equipment with a ground pressure not exceeding 5 psi and a total weight not exceeding 750 lbs will normally be allowed. Typical equipment that is usually used during installation and testing and allowed on the geomembrane include air compressors, generators, etc. Materials, equipment, or other items shall not be dragged across the geomembrane surface or be allowed to slide down slopes on the lining. All parties walking or working on the liner shall wear soft-sole shoes. No smoking shall be permitted on the liner.

### 3.3 FIELD SEAMS

- A. A capable hot air welder or a wedge welder shall be used to seal factory-fabricated panels together in the field.
- B. Field seams shall be made as a lap joint formed by lapping the edges of the sheets four (4) to six (6) inches in accordance with the recommendations of the welder manufacturer. The contact surfaces of the sheets shall be wiped clean of all dirt, moisture, and other foreign matter. A minimum of one and one half inch (1.5”) bond shall apply to all liner field seams.
- C. Avoid fishmouths, wrinkles, folds, or pleats in the same area. Where fishmouths do occur, they should be slit out far enough from the seam to dissipate them, lapped, seamed together in the lapped area, and patched. Any necessary repairs to the RPP geomembrane shall be done using an additional piece of the specified parent material applied as stated in this specification. All patching material shall have rounded edges.
- D. Seams shall be welded only when ambient temperature is between 32°F and 110°F as measured six inches above the geomembrane surface unless the Engineer approves other limits, in writing. For temperatures below 32°F, the following procedures shall be utilized:

1. When the weather is clear and sunny with gentle winds (10 mph or less) welding can normally be performed at an ambient temperature between 32°F and 15°F (liner temperature is usually warmer than ambient due to the sun) without additional provisions other than adjusting the welding machine. Welding temperatures and machine speeds are adjusted to compensate for cloudy weather and higher winds (up to 25 mph).
2. For temperatures between 15°F and 5°F some means of preheating the liner other than that provided by the welding machine is needed. Details of the preheat (space heaters, temporary shelters, and combinations of the two) will be determined by the individual job conditions. The CONTRACTOR shall measure and record the following variables:
  - a. Liner Temperature (surface contact thermometer)
  - b. Ambient Temperature (6" above liner)
  - c. Wedge Temperature During Welding
  - d. Wedge Speed
  - e. Temperature Set Point of Wedge
3. The wedge temperature during welding must be observed and recorded. After starting a seam the temperature is observed and recorded every 20 feet for the first 60 feet or until the wedge temperature appears to have stabilized. After the temperature has stabilized the wedge temperature is observed and recorded every 15 minutes.
4. No welding can take place when it is snowing, sleeting, or raining. Snow and ice must be moved from the liner prior to welding. Snow removal is the responsibility of the general CONTRACTOR. Snow blowers are typically used to remove the top portion of snow leaving the lower 2 to 3 inches above the liner to be carefully removed by hand using plastic shovels or brooms.

### 3.4 INSPECTION AND TESTING OF FIELD SEAMS

- A. Upon completion of the liner installation, all seams shall be visually inspected for compliance with these specifications. In addition to visual inspection, all field seams shall be checked using an air lance nozzle directed on the upper edge and surface to detect any loose edges or ripples indicating unbonded areas within the seam (ASTM D 4437).
- B. All field seams shall be tightly bonded on completion of the work. Any geomembrane surface showing injury due to scuffing, penetration by foreign objects, or distress from other causes shall be replaced or repaired. All exposed scrim edges shall be sealed with an extrusion weld or capped with a strip of polypropylene.
- C. Destructive test seams are to be made by each seaming crew, at the beginning of the seaming process and every four (4) hours thereafter, or every time equipment is changed. Test seams shall be made under the same surface and environmental

conditions as the production welds (i.e., in contact with geomembrane subsurface and similar ambient temperature). These seams are to be made of like materials provided for the purpose of testing and not cut from the seamed panels. Each seaming crew and the materials they are using must be traceable and identifiable to their test seams. The samples shall be numbered, dated, and identified as to the personnel making the seam, and location made by appropriate notes on a print of the panel layout for the project. The completed field seam sample shall measure not less than 14 inches in width and 24 inches in length.

- D. The field test seams are to be tested for seam strength and peel adhesion using equipment suitable for this purpose. Seam shear strength shall be tested in accordance with ASTM 0751 (modified to use one-inch wide specimens and a test speed of 2 in/min). Peel adhesion strength shall be tested in accordance with ASTM 0413, Method A. The geomembrane installer shall provide a punch press or other suitable means for the on-site preparation of specimens for testing. The geomembrane installer shall provide a tensiometer for on-site shear and peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM specifications, and accompanied by evidence of recent calibration.
- E. If a test seam fails to meet the field seam design specification, then the seaming crew shall make additional test seam samples, using the same tools, equipment, environmental conditions, and seaming materials and retested.

### 3.5 PIPES AND STRUCTURE PENETRATION SEALING SYSTEM

- A. Penetrations shall be sealed using the same RPP geomembrane material, prefabricated boots, and accessories as shown on the project drawings. The prefabricated or field fabricated assembly shall be field welded to the main RPP geomembrane as shown on the project drawings so as to prevent leakage.
- B. These areas can be welded with any of the methods listed for Field Seams
- C. All sealed areas shall be air lance tested using ASTM D4437 and verified to be leak free.

### 3.6 REPAIRS

- A. Any repairs made to the liner shall be made with parent material supplied by the membrane manufacturer. Repairs shall be made with newly manufactured material. Patches shall be cut with rounded corners and shall extend a minimum of four 4 inches in each direction from the damaged area. The entire surface of the patch shall be bonded to the RPP lining material. If reinforced patches are used, the cut edges of the patch should be coated with an approved sealant or sealed with an extrusion weld.

- END OF SECTION -



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## SECTION 31 11 00 - SITE PREPARATION

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. In its initial move onto the Site, the CONTRACTOR shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

#### 1.2 SITE INSPECTION

- A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and facilities delineating the OWNER's property and right-of-way lines.

### PART 2 -- PRODUCTS (NOT USED)

### PART 3 -- EXECUTION

#### 3.1 PRIMARY HATCHERY SITE ACCESS

- A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.
- B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

#### 3.2 CLEARING, GRUBBING, AND STRIPPING

- A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping, broken up for use in riprap application (as they are able to meet specification 31 37 00), or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.
- B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

- C. The entire area to be affected by construction shall be stripped to a depth of 1.5-feet below the existing ground contours. The stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.
- D. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base that are outside of the grading limits shall not be removed without the ENGINEER's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary, for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.

### 3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

- A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require over-excavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. The over-excavated volumes to a level 1.5-feet below the existing ground contours shall be backfilled.
- B. After removal of organic laden soil, the remaining soils that will require removal from the bedrock surface prior to the placement of embankment fill include:
  - 1. Topsoil: This soil mantles the stony clay that comprises much of the site.
  - 2. Alluvium: This material is present in the areas surrounding Fall Creek, and will be in a loose, unconsolidated condition.
  - 3. Colluvium: This material is also present on the hillsides and covers portions of the valley floor, particularly on the southern and western slopes of the site. This material will also be in a loose, unconsolidated condition.
- C. Any undesirable topsoil, alluvium, or colluvium shall be removed to the level designated by the ENGINEER and stockpiled for subsequent use as the first material to be placed in the compacted fill.
- D. Any steep, very abrupt rock faces and irregularly shaped rock outcrops of bedrock shall be regraded as directed by the ENGINEER.

- END OF SECTION -

## **SECTION 31 23 00 - CONTROLLED LOW STRENGTH MATERIAL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide Controlled Low Strength Material (CLSM), complete and in place, in accordance with the Contract Documents.
- B. CLSM shall be placed where indicated and may be used, if the ENGINEER approves, for the following purposes:
  - 1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings:
  - 1. CLSM mix designs which show the proportions and gradations of materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.
  - 2. If the CONTRACTOR proposes to provide lower strength CLSM with aggregates that do not conform to ASTM C 33 - Concrete Aggregate, Shop Drawings shall include a testing program that will be used to control the variability of the aggregates. The testing program shall be acceptable to the Engineer.

#### **1.3 QUALITY CONTROL**

- A. Testing will be performed by a testing laboratory selected by the OWNER at the OWNER's expense, except as otherwise indicated.
- B. If tests of the CLSM show non-compliance with the specifications, the CONTRACTOR shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be the CONTRACTOR's responsibility.
- C. Correlation Tests
  - 1. The CONTRACTOR shall perform a field correlation test for each mix of CLSM used in pipe zone, trench zone, or backfill used in amounts greater than 100-cubic yards or when CLSM is required to support traffic or other live loads on the fill less than 7 Days after placing CLSM.
  - 2. Field correlation tests shall be performed in a test pit similar in cross section to the WORK and at least 10-feet long at a location near the WORK. The proposed location shall be acceptable to the ENGINEER.

3. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. Tests shall be performed by a laboratory at the CONTRACTOR's expense.
4. Testing shall be performed once each 2 hours during the first 8 hours, once each 8 hours during the first week, and once each 24 hours until the CLSM mix reaches the maximum design strength.
  - a. Compression testing shall be in accordance with ASTM D 4832 - Preparation and Testing of Soil-Cement Slurry Test Cylinders.
  - b. Setting test shall be in accordance with ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance
  - c. Density tests shall be in accordance with ASTM C 138 - Unit Weight, Yield and Air Content (Gravimetric) of Concrete.

## **PART 2 -- PRODUCTS**

### **2.1 CONTROLLED LOW STRENGTH MATERIAL**

- A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C 94 - Ready Mixed Concrete.
- B. **Composition:** The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.
  1. Mix proportions as necessary
  2. Entrained air content shall be between 0 percent minimum and 6 percent maximum.
  3. Water reducing agent content as necessary
- C. Properties
  1. Density shall be between 120 PCF minimum and 145 PCF maximum
  2. Slump shall be as required by the CONTRACTOR's methods but shall not promote segregation nor shall slump exceed 9 inches.
  3. Compressive strength at 28 Days:
    - a. Normal CLSM: Between 100 psi minimum and 300 psi maximum. Unless specifically indicated otherwise, CLSM shall be Normal CLSM.

### **2.2 CEMENT**

- A. Cement shall be Type I or II in accordance with ASTM C 150 - Portland Cement.

## 2.3 POZZOLAN

- A. Pozzolan shall be Type F or C in accordance with ASTM C 618 – Fly ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete. Pozzolan content, by weight, in Normal CLSM shall not be greater than cement content.

## 2.4 AGGREGATE

- A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1/2-inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73 (liquid limit-20), when tested in accordance with ASTM D 4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils. Aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

## 2.5 ADMIXTURES

- A. Air entraining admixtures shall be in accordance with ASTM C 260 - Air-Entraining Admixtures for Concrete.
- B. Water reducing admixtures shall be in accordance with ASTM C 494 - Chemical Admixtures for Concrete.

## 2.6 WATER

- A. Water shall be potable, clean, and free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

# PART 3 -- EXECUTION

## 3.1 PREPARATION

- A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 31 00 00 - Earthwork.

## 3.2 BATCHING, MIXING AND DELIVERY

- A. Batching, mixing, and delivery of CLSM shall conform to ASTM C 94. CLSM shall be mixed at a batch plant acceptable to the ENGINEER and shall be delivered in standard transit mix trucks.

## 3.3 PLACEMENT

- A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means. CLSM shall be directed in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

- B. CLSM shall be continuously placed against fresh material unless otherwise approved by the ENGINEER. When new material is placed against existing CLSM, the placement area shall be free from loose and foreign material. The surface of the existing material shall be soaked a minimum of one hour before placement of fresh material, but no standing water shall be allowed when placement begins.
- C. Temperature of the CLSM shall be between 50- and 90-degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

#### 3.4 FINISHING

- A. The finish surface shall be smooth and to the grade indicated or directed by the ENGINEER. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

#### 3.5 CURING

- A. CLSM shall be kept damp for a minimum of 7 Days or until final backfill is placed.

#### 3.6 PROTECTION

- A. CLSM shall be protected from freezing for 72 hours after placement.
- B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C 803 - Standard Test Method for Penetration Resistance of Hardened Concrete, exceeds 650 psi.
- C. CLSM shall be protected from running water, rain, and other damage until the material has been accepted and final fill completed.

- END OF SECTION -

## **SECTION 31 23 19 - DEWATERING**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall dewater trench and structure excavations, and behind all cofferdams and protective works in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Prior to commencement of excavation, or any work inside of the Ordinary High Water level, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations and cofferdams. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations and cofferdams at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

#### **1.3 QUALITY CONTROL**

- A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- B. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the CONTRACTOR. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the CONTRACTOR.

### **PART 2 -- PRODUCTS**

#### **2.1 EQUIPMENT**

- A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.



## **PART 3 -- EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.
- B. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.
- C. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.
- F. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance. Likewise, the CONTRACTOR shall maintain the water level below the bottom of the cofferdam protected areas for the entire duration that the cofferdams are in place.
- G. Flotation shall be prevented by the CONTRACTOR by maintaining a positive and continuous removal of water. The CONTRACTOR shall be fully responsible and liable for all damages which may result from failure to adequately keep areas of work dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- I. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the ENGINEER. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

- J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.
- K. Dewatering of trenches, excavations, and cofferdam protected areas shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms, unless a separate bid item has been established for dewatering.

- END OF SECTION -

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## SECTION 31 32 23 - SOIL STABILIZATION

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall stabilize the soil utilizing chemical grout for open-cut excavation and the application of air-placed concrete to the face of the excavation without shoring.
- B. Chemical grout shall be a relatively nonviscous solution, not a slurry, that may be injected into a permeable soil mass, undergo chemical reactions that lead to metathetical precipitation or polymerization, and result in solidification of that injected soil by binding together the soil grains for the purpose of increasing the load bearing capacity of the soil.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Detailed sketches of the intended injection techniques and patterns, including necessary data to prove that the chemicals contemplated will meet in all respects the requirements as to properties and qualities required by these Specifications. Any test data furnished by the CONTRACTOR substantiating the adequacy of the grout shall be from a certified testing lab.
- C. **Subcontractor Qualifications:** The CONTRACTOR shall submit satisfactory documentation that project personnel have the requisite experience and qualifications as outlined below.
- D. **Daily Data Logs:** The CONTRACTOR shall submit to the ENGINEER daily data logs of test samples for every injection batch and records of the point of injection for every batch.

#### 1.3 QUALITY CONTROL

- A. **Subcontractor Qualifications:** WORK under this Section shall be performed by a CONTRACTOR having at least 5 years of experience in the field of chemical grout soil stabilization and underpinning and having successfully completed at least 5 projects of a similar nature.

#### 1.4 WORK COORDINATION

- A. The CONTRACTOR shall fully coordinate the WORK of this Section with that of other trades involved and with the ENGINEER to ensure proper sequence, limitation, methods, and time of working so as to minimize or avoid interferences as well as performance of WORK by other trades.

## **PART 2 -- PRODUCTS**

### **2.1 MATERIALS**

- A. The solidified soil shall have an unconfined compressive strength of 50 psi at 28 days.
- B. The CONTRACTOR shall be responsible for formulation of the grout. Chemicals used shall be sodium silicate based with catalyst that will provide the required chemical grout. Water used shall be compatible with the chemical system to be used.
- C. Considering the chemistry of the gel and the conditions known at the Site, the chemical system used shall produce a stable gel. The chemical system used shall stabilize soil to permit open-cut excavation and the application of air-placed concrete to the face of the excavation without use of any shoring. The system shall have a proven record of stability.
- D. The chemicals used shall be so proportioned and mixed as to produce a chemical grout that contains no solids in suspension, may be pumped without difficulty, will penetrate and fill the voids in the soil mass, and will form a gel of the required strength and stability.
- E. Chemicals mixed into primary solutions before final batching may be stored only in accordance with the manufacturer's recommendations and must not be injected if limiting factors imposed by the manufacturer are exceeded. Any solutions not to be used for injection shall be immediately disposed of. The chemical system shall not be detrimental to the environment. The injected solution and its components shall be nontoxic.

### **2.2 SITE PREPARATION**

- A. The Site is mapped as Quaternary (Qv) and Tertiary (Tv) volcanic rock with nearby landslide deposits (Qls) associated with steep slopes on the east side of Fall Creek and just south of the Project site. Cobble- and boulder-sized rocks were observed on the ground surface at the proposed hatchery site and will likely need to be cleared to support construction. The borings advanced in the Project vicinity indicate approximately 18 inches of fill (road base) overlying slightly to completely weathered basalt. Based on the presence of sand, clay, and root structures at depth, we interpreted the deposit to be colluvium consisting of cobbles and boulders within a clay/sand matrix. Colluvium was interpreted to extend to the depths explored in boring B-13 and to a depth of 13 feet in boring B-14. Highly weathered andesite was observed below the colluvium in boring B-14 and extended to the depth explored (29 feet).
- B. Site clearing, grubbing, and removal shall be in accordance with Section 31 11 00 - Site Preparation. After preparation complete, the CONTRACTOR shall commence soil stabilization.

### **2.3 MIXING**

- A. Materials shall be accurately measured by weight or volume for mixing. If a variable proportioning pump system is used, positive controls shall be incorporated to ensure accurate proportioning. Care shall be taken not to contaminate mixing vessels with reactive chemical by spillage, splash, etc.

- B. A fast check reaction shall be made with each new primary chemical batch. A test sample shall be made of every injection batch. The CONTRACTOR shall keep records to establish the point of injection for each sample. These data shall be submitted daily to the ENGINEER.
- C. If any sample fails to show the proper gelation, the potential area of failure shall be reinjected. The CONTRACTOR shall propose methods of correction.

## **PART 3 -- EXECUTION**

### **3.1 APPLICATION**

- A. The CONTRACTOR shall determine the extent of the soil stabilization required, subject to approval by the ENGINEER.
- B. Care shall be taken in the placing of injection points to secure accurate injection and the proper overlapping of injection cylinders.
- C. Injection rates and pressures shall be closely controlled to prevent blowout, localized "quick" conditions, and to ensure the proper filling of voids to attain the desired stabilized section.
- D. Quantities of chemical grout injected at each point shall be governed by calculated volume, backpressure, or a combination of these 2 factors. If it appears, at any point, that a large void exists, proper steps shall be taken to ensure permeation of the desired soil section.

### **3.2 CLEANUP**

- A. Upon completion of soil stabilization, the CONTRACTOR shall dispose of all excess materials off the Site, leaving the Site clean and orderly, ready for subsequent operations.

- END OF SECTION -

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## **SECTION 31 35 00 - EROSION AND SEDIMENT CONTROL GENERAL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. Work includes furnishing all labor, materials and equipment required for the installation and maintenance of both permanent and temporary erosion and sediment control measures as shown on the drawings and as specified herein.
- B. Erosion and sediment control measures shall remain in place while potential for erosion exists from construction activities at the site and disposal area, during the duration of the contract and warranty period;
  - 1. Protect and stabilize soils susceptible to erosion. This includes areas where vegetative cover cannot be achieved due to soils, slopes or time of year. The contractor shall be aware of and conform to measures necessary for the control of erosion and sediment runoff according to applicable regulations.
  - 2. Prevent sediment or sediment laden water from entering all creeks and the storm drain systems or to be discharged from the construction site in accordance with the California State Water Resources Control Board, USEPA, and other applicable regulations.
- C. All temporary erosion and sediment control measures shall be installed prior to commencement of construction.

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

U.S. DEPARTMENT OF AGRICULTURE (USDA) AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

California State Water Resources Control Board, Best Management Practices for Erosion and Sediment Control

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Submit Stormwater Pollution Prevention Plan (SWPPP) for acceptance in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 01 57 20 – Temporary Environmental Controls.
  - 1. Submit SWPPP for work during construction, prepared by a registered Qualified SWPPP Developer (QSD) and signed and stamped by a registered Civil Engineer prior to the start of construction. Plan shall meet all federal, state, and local requirements.
  - 2. Submit Notice of Intent (NOI).

### **PART 2 – PRODUCTS (NOT USED)**

### **PART 3 -- EXECUTION**

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KRRC – FALL CREEK FISH HATCHERY

EROSION AND SEDIMENT CONTROL  
GENERAL  
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### 3.1 INSTALLATION

- A. Install erosion and sediment control measures per manufacturer's directions or as illustrated on the contract drawing or as identified in Section 31 35 20 – Erosion Control Barriers and Section 31 35 29 – Erosion Control Turbidity Curtain.

### 3.2 MAINTENANCE AND REMOVAL

- B. Repair and reinstall temporary soil erosion control measures as necessary to ensure proper function for the duration of ground disturbing activities and through the warranty period.
- C. Temporary erosion control devices shall be removed only after they have performed their intended function.
- D. All pipes, end sections, drainage curbs, sandbags, sediment fences and other materials which are removed from temporary erosion control devices and not incorporated into the permanent work shall become the property of the CONTRACTOR and shall be removed from the area.

- END OF SECTION -

## SECTION 31 35 20 - EROSION CONTROL BARRIER

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide erosion control barriers, complete and in place, in accordance with the Contract Documents

#### 1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. **Product Data:** Manufacturer's catalog sheets on geotextile fabrics.

### PART 2 -- PRODUCTS

#### 2.1 FABRIC

- A. Fabric may be woven or non-woven, made from polypropylene, polyethylene, or polyamide, and shall contain sufficient UV inhibitors so that it will last for 2 years in outdoor exposure.
- B. Fabric shall have the following properties:

Parameter	Standard Method	Value
Grab tensile strength	ASTM D 4632	100 lb
Burst strength	ASTM D 3786	200 psi
Apparent opening size	ASTM D 4751	Between 200 and 70 sieve size

- C. Fabric Manufacturer, or equal

##### 1. **Mirafi**

#### 2.2 POSTS

- A. Posts shall be wood, at least 2 inches by 2 inches, at least 6 feet long, or
- B. Posts shall be steel, 1 1/2-inch, T-shaped, at least 6 feet long with protective coating.

#### 2.3 FENCING

- A. Woven wire fabric fencing shall be galvanized, mesh spacing of 6 inches, maximum 14-gauge, at least 30 inches tall.

## 2.4 FASTENERS

- A. Fasteners to wood posts shall be steel, at least 1 1/2 inches long, or
- B. Fasteners to steel posts shall be galvanized clips.

## PART 3 -- EXECUTION

### 3.1 PREPARATION

- A. Provide erosion control barriers at the indicated locations and as required to prevent erosion and silt loss from the Site.
- B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

### 3.2 INSTALLATION

- A. Barrier systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
- B. Attach the woven wire fencing to the posts that are spaced a maximum of 6 feet apart and embedded a minimum of 12 inches. Install posts at a slight angle toward the source of the anticipated runoff.
- C. Trench in the toe of the filter fabric barrier with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow. Lay fabric along the edges of the trench. Backfill and compact.
- D. Securely fasten the fabric materials to the woven wire fencing with tie wires.
- E. Reinforced fabric barrier shall have a height of 18 inches.
- F. Provide the filter fabric in continuous rolls and cut to the length of the fence to minimize the use of joints. When joints are necessary, splice the fabric together only at a support post with a minimum 6-inch overlap and seal securely.

### 3.3 MAINTENANCE

- A. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until final acceptance; then remove erosion and sediment control systems promptly.
- B. Remove sediment deposits when silt reaches a depth of 6 inches or 1/2 the height of the barrier, whichever is less. Dispose of sediments on the Site, if a location is indicated on the Drawings, or at a site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

## SECTION 31 35 29 - EROSION AND SEDIMENT CONTROL TURBIDITY CURTAIN

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide instream trapping devices specifically designed to limit sediment transport impacts within a body of water. Turbidity curtains and other instream sediment trapping devices shall provide sedimentation protection for in-stream, bank, or upslope ground disturbance or from dredging or filling within a waterway.
- B. WORK shall include furnishing all labor, materials, and equipment required for the installation and maintenance of instream sediment trapping devices, complete and in place, in accordance with the Contract Documents
- C. CONTRACTOR shall be responsible for following all applicable Federal, State, and local codes and regulations, including the California State Water Resources Control Board requirements and best management practices.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. **Product Data:** Manufacturer's catalog sheets on turbidity curtain fabrics.

### PART 2 -- PRODUCTS

#### 2.1 FABRIC

- A. Strong heavy-weight material with ultraviolet light (UV) inhibitors.
- B. Tensile strength shall be sufficient to withstand predicted flows.
- C. Seams and line attachments shall be sewn or vulcanized welded into place.
- D. Flotation devices shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain.

#### 2.2 ANCHORS

- A. In-stream anchors shall have a floating anchor buoy or other identifying mark.
- B. Shoreline turbidity curtain anchors shall be 2- by 4-inch or 1.33-lbs/lineal foot metal stakes.
- C. Bottom anchors shall hold the curtain in position and may be any of the following types: plow, fluke, mushroom, or a grappling hook.

## **PART 3 -- EXECUTION**

### **3.1 PREPARATION**

- A. Provide erosion control barriers at the indicated locations and as required preventing erosion and silt loss from the Site.
- B. CONTRACTOR shall not commence clearing, grubbing, earthwork, or other activities which may cause erosion until barriers are in place.

### **3.2 INSTALLATION**

- A. For manufactured products, install per manufacturer's instructions.
- B. Install turbidity curtains parallel to flow of the watercourse.
- C. Turbidity curtain shall extend the entire depth of the watercourse.
- D. In areas heavily impacted by wind generated wave action; turbidity curtains should have slack to follow the rise and fall of the water level without submerging.
- E. Set upstream anchor points first, then unfurl the fabric, letting the flow carry the fabric to the downstream anchor points.

### **3.3 MAINTENANCE AND REMOVAL**

- A. Follow manufacturer instructions for fabric and material repair.
- B. Remove materials at low flows and in a manner to scoop and trap sediments within the fabric.
- C. Regularly inspect and repair or replace damaged components of the barrier. Unless otherwise directed, maintain the erosion control system until the disturbed area is permanently stabilized or upon final acceptance; then remove erosion and sediment control systems promptly.
- D. Dewater and dispose of sediments on the Site, if a location is indicated on the Drawings, or at an approved site arranged by the CONTRACTOR which is not in or adjacent to a stream or floodplain.

- END OF SECTION -

## SECTION 31 35 30 - EROSION AND SEDIMENT CONTROL (VEGETATIVE)

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for all disturbed areas that are not to be paved or otherwise treated in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Seed Mix. Submit 30 days prior to seeding activities.
  - 1. Seed mix and supplier application recommendations.
  - 2. California State Seed Law and Phytophthora-free certifications.
  - 3. Supply written guarantees offered by the seed supplier.
- C. Product Literature. Submit 30 days prior to seeding activities.
  - 1. Supply manufacturer's product literature for both the mulch material and erosion control blanket, including any recommended mix rates, application procedures, or anchorage devices and patterns.

### PART 2 -- PRODUCTS

#### 2.1 MATERIALS

- A. **Fertilizer:** Fertilizer shall be a commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Commercial fertilizer should conform to the requirements of the California Food and Agricultural Code.
- B. **Seed:** Seed shall be delivered in original unopened packages bearing an analysis of the contents. Seed shall be guaranteed 95 percent pure with a minimum germination rate of 80 percent, and shall meet California State Seed Law.
  - 1. Seed mix shall consist of brome, perennial ryegrass, barley, fescue, wheatgrass, and clover native to the Upper Klamath watershed, or some combination of two or more of the above.
  - 2. The seed mix shall conform to the final seed mix selected in the SWPPP.
  - 3. The seed mix shall have weed-free certifications and Phytophthora-free certifications.

4. Seed mix shall be fast growing species that can be established with normal rainfall and without supplemental irrigation.
  5. Seed mix shall be subject to the approval of the OWNER and ENGINEER.
- C. **Mulch:** Mulch shall be a fibrous, wood cellulose product produced for this purpose. It shall be dyed green and shall contain no growth or germination inhibiting substances and shall be manufactured so that when thoroughly mixed with seed, fertilizer, and water, in the proportions indicated it will form a homogenous slurry which is capable of being sprayed. The mulch shall be **Silva Fiber** as manufactured by **Weyerhaeuser Company**; **Conwood Fiber** as manufactured by **Consolidated Wood Conversion Corp.**; or equal.
- D. Erosion Control Blanket: Erosion control fabric shall be used on all slopes 4H:1V and steeper.
1. Materials: Erosion control fabric shall be rolled, fiber matrix between biodegradable or photodegradable polypropylene nets, and shall have a design life of 12 months or greater.
  2. Anchorage Devices: 6-inch biodegradable stakes from the manufacturer or staples of the proper length as recommended by the manufacturer for specific soil condition.
- E. Manufacturers, or Equal
1. **North American Green**

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. **Weather Conditions:** Fertilizing, seeding, or mulching operations will not be permitted when wind velocities exceed 15 miles per hour or when the ground is frozen, unduly wet, or otherwise not in a tillable condition.
- B. **Soil Preparation:** The ground to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks, roots, and other material which will interfere with the work.
- C. **Method of Application:** Fertilizer, seed, and mulch may be applied separately (Dry Method), or they may be mixed together with water and the homogeneous slurry applied by spraying (Hydraulic Method), except that all slopes steeper than 3 units horizontal to 1 unit vertical shall be stabilized by the Hydraulic Method.

### **3.2 DRY METHOD**

- A. **Fertilizing:** The fertilizer shall be spread uniformly at the rate recommended by the seed supplier for the selected seed mix. The fertilizer shall be raked in and thoroughly mixed with the soil to a depth of approximately 2-inches prior to the application of seed or mulch.

- B. **Seeding:** The seed shall be broadcast uniformly at the rate of 44 lbs/acre (approximately 1 lb per 1,000 sq ft), or as recommended by the seed supplier. After the seed has been distributed it shall be incorporated into the soil by raking or by other approved methods.
- C. **Mulch Application:** Mulch shall be applied at the rate of 1,500 lb (air dried weight) per acre (approximately 1 lb per 30 sq ft).

### 3.3 HYDRAULIC METHOD

- A. The hydraulic method consists of the uniform application by spraying of a homogeneous mixture of water, seed, fertilizer, and mulch. The slurry shall be prepared by mixing the ingredients in the same proportions as indicated above. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. Mixing time of materials shall not exceed 45 minutes from the time the seeds come into contact with the water in the mixer to the complete discharge of the slurry onto the slopes, otherwise the batch shall be recharged with seed. The mixture shall be applied using equipment containing a tank having a built-in, continuous agitation and recirculation system, and a discharge system which will allow application of the slurry to the slopes at a continuous and uniform rate. The application rates of the ingredients shall be the same as those specified for the Dry Method. The nozzle shall produce a spray that does not concentrate the slurry nor erode the soil.

### 3.4 EROSION CONTROL BLANKET

#### A. Placement

1. Biodegradable erosion control blanket shall be used on all slopes 4H:1V and steeper.
2. The erosion control shall be spread only on prepared, fertilized and seeded surfaces.
3. On all slopes, the erosion control blanket shall be laid up-and-down the slope in the direction of water flow.
4. Waste of erosion control material shall be minimized by limiting overlaps as specified and by utilizing the full length of the netting at roll ends.

#### B. Anchorage

1. Ends and sides of adjoining pieces of material shall be overlapped 6-inches and 4-inches respectively, and stapled. Six anchors shall be installed across ends. A common row of staples shall be used at side joints. Staple through both blankets, placing staples approximately 6-inches apart.
2. The top edge of the erosion control blanket shall be anchored in a 6-inch deep by 6-inch wide trench. Backfill and compact trench after stapling.
3. Anchorage shall be by means of 6-inch biodegradable stakes, or staples recommended by the manufacturer, driven vertically and full-length into the ground.



The legs shall be spread 3-inches to 4-inches apart at the ground to improve resistance to pull-out. In loose soils the use of 18-inch metal/washer pins may be required to properly anchor the blankets.

4. All slopes which are 4:1 or greater shall be stapled with 2 staples per square yard in a triangular pattern. Staples shall be installed per the manufacturer's recommended staple pattern guide.
5. The erosion control blanket shall not be stretched but should be laid loosely over the ground to avoid pulling the blanket downslope.
6. The erosion control blanket shall not be rolled out onto ground containing frost within the 6-inch penetration zone of the anchorage stakes or staples. Further, no staking or stapling shall be undertaken while any frost exists within the penetration zone.

### 3.5 WATERING

- A. Upon completion of the erosion control seeding, the entire area shall be soaked to saturation by a fine spray. The new planting shall be kept watered by a sprinkling system on the Site during dry weather or whenever necessary for proper establishment of the planting until final project acceptance. At no time shall the planting be allowed to dry out. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the CONTRACTOR.

### 3.6 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

- A. The CONTRACTOR shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary, and sufficient watering to maintain the plant materials in a healthy condition. The ENGINEER may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

- END OF SECTION -

## SECTION 31 37 00 - RIPRAP

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide riprap, including associated earthwork, complete and in place, in accordance with the Contract Documents.

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

ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 535	Standard Test Method for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
AASHTO T 85	Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
AASHTO T 210	Method of Test for Aggregate Durability Index.

#### 1.3 CONTRACTOR SUBMITTAL

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Testing certificates from a qualified testing agency shall be submitted prior to acceptance of the rock source to verify the conformity to the requirements of the Contract Documents.

### PART 2 -- PRODUCT

#### 2.1 STONES FOR RIPRAP

- A. Stones shall be graded in size to produce a reasonably dense mass. Riprap shall consist of dense, natural rock fragments. Stones shall be resistant to weathering and to water action; free from overburden, spoil, shale, and organic material; and shall meet the gradation requirements below. Shale and stones with shale seams are not acceptable.
- B. Riprap shall conform to the size types as follows:
1. Type I (6-inch Average Size):

Diameter	Percentage Passing
12-inch	95 - 100

6-inch	25 - 75
3-inch	0 - 10

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** – Class I Rock Slope Protection material.

2. Type II (12-inch Average Size):

Diameter	Percentage Passing
18-inch	95 - 100
12-inch	25 - 75
6-inch	0 - 5

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** – Class III Rock Slope Protection material.

3. Type III (18-inch Average Size):

Diameter	Percentage Passing
24-inch	95 - 100
18-inch	25 - 75
13-inch	0 - 5

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** – Class V Rock Slope Protection material.

4. Type IV (24-inch Average Size):

Diameter	Percentage Passing
30-inch	95 - 100
24-inch	25 - 75
18-inch	15 - 25
12-inch	0 - 5

As an alternative to the above gradation, the CONTRACTOR may use the approved State of California Department of Transportation's **CalTrans** – Class VII Rock Slope Protection material.

- C. The greatest dimension of 50 percent of the stones shall be at least two-thirds but not more than 1-1/2 times the diameter of the average size. Neither the breadth nor thickness of any piece of riprap shall be less than one-third its length. Material shall be of shapes which will form a stable protection structure of required depth. Rounded boulders or cobbles shall not be used.
- D. Stones shall consist of durable, sound, hard, angular rock meeting the following requirements for durability absorption ratio, soundness test, and abrasion test:

<b>Durability Absorption Ratio</b>	<b>Acceptability</b>
Greater than 23	Passes
10 to 23	Passes only if Durability Index is 52 or greater
Less than 10	Fails
Durability Absorption Ratio	<u>Durability Index (Coarse)</u> % absorption + 1

- E. The durability index and percent absorption shall be determined by AASHTO T 210 and AASHTO T 85, respectively. The minimum apparent specific gravity of the stones shall be 2.5 as determined by AASHTO T 85.
- F. Stones shall have less than 10 percent loss of weight after five cycles, when tested per ASTM C 88.
- G. Stones shall have a wear not greater than 40 percent, when tested per ASTM C 535.
- H. Control of gradation shall be by visual inspection. The CONTRACTOR shall furnish a sample of the proposed gradation of at least 5 tons or 10 percent of the total riprap weight, whichever is less. If approved, the sample may be incorporated into the finished riprap at a location where it can be used as a frequent reference for judging the gradation of the remainder of riprap.
- I. The acceptability of the stones will be determined by the ENGINEER prior to placement. Any difference of opinion between the ENGINEER and the CONTRACTOR shall be resolved by dumping and checking the gradation of two random truckloads of stones. Arranging for and the costs of mechanical equipment, a sorting site, and labor needed in checking gradation shall be the CONTRACTOR's responsibility.

## 2.2 GEOTEXTILE FABRIC

- A. Geotextile fabric shall conform to the requirements of Section 31 05 19 - Geotextiles.

## 2.3 FILTER MATERIAL

- A. Filter material shall be clean and free from organic matter. It shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformity graded and shall conform to the following gradation:

1. Type 1

Size	Percentage Passing
3-inch	85 – 100
1-1/2 inch	45 – 75
3/4-inch	10 – 25

2. Type 2: CLASS 2, 1-1/2-inch aggregate base material, as described in Specification Section 26 of the Caltrans Standard Specifications is acceptable as Type 2 filter material.

## PART 3 -- EXECUTION

### 3.1 SURFACE PREPARATION

- A. Surfaces to receive riprap shall be smooth and firm, free of brush, trees, stumps, and other objectionable material, and shall be brought to the line and grade indicated.
- B. If a boulder is encountered during excavation of areas where large riprap is to be placed, the CONTRACTOR shall excavate around the boulder. If the boulder is larger than the largest allowable stone size for that area, the CONTRACTOR shall break up the boulder to an acceptable size or remove it entirely.
- C. Prior to placement of the geotextile, the surface shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile. The geotextile shall be overlapped a minimum of 2-feet at longitudinal and transverse joints. Upstream sheets shall overlap downstream sheets. For slope placement, each strip shall overlap the next downhill strip. The geotextile shall be anchored using key trenches or aprons at the crest and toe of the slope. Pins may be used in securing the geotextile during installation. In no instance shall the geotextile be left exposed to sunlight longer than 7 Days. Overexposed geotextile shall be removed and replaced.

### 3.2 PLACEMENT OF FILTER BLANKET

- A. Area of riprap placement shall be excavated to the bottom of the filter blanket as indicated and in accordance with Section 31 00 00 – Earthwork. After the excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 percent of maximum density. The finished grade shall be even, self-draining, and in conformance with the slope of the finished grade.

- B. Placement of filter material shall be in accordance with Section 31 00 00. Filter material shall be placed, spread, and compacted in lifts not to exceed 12-inches.
- C. The CONTRACTOR shall remove any portion of the filter blanket that has been disturbed to the degree that the layers become mixed. Replace the removed portion with the required sizes.
- D. Filter material shall be placed as follows, unless otherwise indicated.
  - 1. For Type II, III and IV riprap, use 12-inches of Type 1 filter material.
  - 2. For Type I riprap, use 6-inches of Type 2 filter material.
- E. No filter material is required if riprap is placed directly on bedrock.

### 3.3 PLACEMENT OF RIPRAP

- A. Placement of riprap shall begin at the toe of the slope and proceed up the slope. The stones may be placed by dumping and may be spread by bulldozers or other suitable equipment as long as the underlying material is not displaced. Stones shall be placed so as to provide a minimum of voids. Smaller stones shall be uniformly distributed throughout the mass. Sufficient hand work shall be done to produce a neat and uniform surface, true to the lines, grades, and sections indicated.
- B. Where riprap is placed over a geotextile fabric, the riprap shall be placed so as to avoid damage to the geotextile. Stones shall not be dropped from a height greater than 3-feet, nor shall large stones be allowed to roll downslope.

- END OF SECTION -

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## SECTION 32 11 13 - A.C. PAVEMENT AND BASE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

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

##### A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 320	Standard Specification for Performance-Graded Asphalt Binder
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
ASTM D 6373-16	Standard Specification for Performance Graded Asphalt Binder
AI MS-2	Asphalt Mix Design Methods, 7 <sup>th</sup> Edition ( <i>Asphalt Institute</i> )

##### B. State Standards



### 1.3 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include job-mix formulas and other pertinent information satisfactory to the ENGINEER.
- B. **Suitability Tests of Proposed Materials:** Tests for conformance with the Specifications shall be performed prior to start of the WORK. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

## PART 2 -- PRODUCTS

### 2.1 AGGREGATE BASE

- A. Materials for aggregate base shall be Type GF material in accordance with Section 31 00 00 - Earthwork.

### 2.2 PRIME COAT

- A. Prime coat shall be Type RS-2 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027) and Caltrans Standard Specifications, Section 94, Asphaltic Emulsions.

### 2.3 TACK COAT

- A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt grade 64-22. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

### 2.4 ASPHALT CEMENT

- A. Asphalt Cement shall be Performance Grade 64-22 complying with the requirements of AASHTO M320 (ASTM D 6373-16).

### 2.5 MINERAL AGGREGATE

- A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

- B. Mineral filler shall comply with ASTM D 242.
- C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

## 2.6 ASPHALT-AGGREGATE MIXTURE

- A. Asphalt-aggregate mix shall be Performance Grade 64-22, 1/2" maximum aggregate size Type A HMA per CalTrans specifications 39-2.02B(4)(b) and shall comply with Superpave HMA mix design, material specifications, and testing as described in MS-2 Asphalt Mix Design Methods by the *Asphalt Institute*.

## 2.7 PAVEMENT MARKING PAINT

- A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability.

# PART 3 -- EXECUTION

## 3.1 SUBGRADE PREPARATION

- A. The subgrade shall be prepared in accordance with Section 31 00 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

## 3.2 AGGREGATE BASE

- A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6-inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

## 3.3 PRIME COAT

- A. Prior to placing of pavement a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

### 3.4 TACK COAT

- A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

### 3.5 ASPHALT CONCRETE

- A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.
- B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.
- C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.
- D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the ENGINEER may waive the self-propelled requirement.
- E. Spreading, once commenced, shall be continued without interruption.
- F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.
- G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.
- H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

### 3.6 PAVEMENT MARKING

- A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions indicated. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the ENGINEER.

- END OF SECTION -

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## SECTION 32 31 13 - CHAIN LINK FENCING AND GATES

### PART 1 -- GENERAL

#### 1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide chain link fencing and gates and appurtenant WORK, complete and operable, in accordance with the Contract Documents.
- B. **Single Manufacturer:** Chain link fencing, gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

#### 1.2 CONTRACTOR SUBMITTALS

- A. General: Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings
  - 1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.
  - 2. Scale layout of fencing, gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, barbed wire support arms and other accessories which may be necessary.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.
- B. Fence fabric height shall be 8 feet unless otherwise indicated.
- C. Fencing materials shall be hot-dip galvanized after fabrication.
- D. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms sloped outward, unless indicated otherwise on the Contract Drawings.
- E. Match Style, finish, and color of each fence component with that of other fence components.

#### 2.2 STEEL FABRIC

- A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

- B. **Fabric Finish:** Fabric shall be galvanized in conformance with ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, Class II, with not less than 2.0 ounces zinc per square foot of coated surface.
- C. Height: 96 inches, unless shown otherwise.

## 2.3 FRAMING AND ACCESSORIES

- A. **Steel Framework, General:** Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.
  - 1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8-ounce zinc per square foot of coated surface.
- B. **End, Corner and Pull Posts:** Posts shall be one-piece without circumferential welds, 3-inch schedule 40 pipe, 5.79 pounds per linear foot.
- C. **Line Posts:** Line posts shall be spaced no more than 10-feet on center and shall be 2-1/4 inch "H" column section, 4.1-pounds per linear foot, or schedule 40, 2-1/2-inch pipe, 3.65-pounds per linear foot.
- D. **Gate Posts:** Gate posts shall be 4-inch schedule 40 pipe, 9.1-pounds per linear foot.
- E. **Top Rail:** Top railing shall be provided in manufacturer's longest lengths, with expansion type couplings, approximately 6-inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8-inch schedule 40 pipe, 2.27-pounds per linear foot, or 1-1/2 inch "H" column section, 2.00-pounds per linear foot.
- F. **Tension Wire:** Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24-inches apart.
- G. **Fabric Tie Wires:** Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14-inches apart on posts and 24-inches apart on rails.
- H. **Post Brace Assembly:** Post brace assembly shall be manufacturer's standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.

- I. **Stretcher Bars:** Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16-inch by 3-1/2 inch. One stretcher bar shall be provided for each gate and end post, and 2 for each corner and intermediate brace post.
- J. **Stretcher Bar Bands:** Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8-inch by 3/4-inch. Stretcher bar bands shall be spaced no more than 15-inches on center.
- K. **Barbed Wire Supporting Arms:** Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.
- L. **Barbed Wire:** Barbed wire shall be 2-strand, No. 12-1/2-gauge zinc-coated steel or iron wire with four-point, 14-gauge barbs spaced no more than 5-inches apart.

## 2.4 GATES

- A. **Fabrication:** Perimeter frames of gates shall be fabricated from same metal and finish as fence framework. Gate frames shall be assembled by welding or with fittings and rivets for rigid, secure connections. Welds shall be ground smooth. Gate frames and any ungalvanized hardware, shall be hot-dip galvanized after fabrication. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric, hardware and shall be hot-dip galvanized after fabrication.
  - 1. Fabric for gates shall match fence fabric, unless otherwise indicated. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15-inches on center.
  - 2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.
  - 3. Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.
- B. **Swing Gates:** Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.
  - 1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:
- C. **Hinges:** Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Three hinges shall be provided for each leaf 6-feet or more in height.



- D. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.
- E. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.
- F. Double Gates: Gate stops shall be provided for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Locking device and padlock eyes shall be provided as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

## 2.5 RELATED ITEMS

- A. **Concrete:** Concrete shall be provided according to Section 03 30 00 - Cast-In-Place Concrete.
- B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

## 2.6 MANUFACTURERS

- A. **Manufacturer's Qualifications:** Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.
- B. **Installer's Qualifications:** Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.
- C. Manufacturers, or equal
  - 1. **American Fence Corp.**
  - 2. **Anchor Fence, Inc.**
  - 3. **United States Steel**

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. Prior to commencing installation, require Installer to inspect all areas and conditions within which WORK of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

### 3.2 INSTALLATION

- A. **General:** Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected.

- B. **Excavation:** Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:
1. Holes shall be excavated to a diameter not less than 12-inches or not less than 5 times the largest dimension of the item being anchored, whichever is larger.
  2. Depth for holes shall be not less than 40-inches; excavated approximately 4-inches lower than the post bottom, with bottom of posts set not less than 36-inches below finish grade surface.
- C. **Setting Posts:** Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb and shall be centered in holes, 4-inches above the bottom of the excavation, with posts extending not less than 36-inches below finish grade surface.
1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.
  2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.
- D. **Concrete**
1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened. Remove soil and debris from excavation prior to filling the hole with concrete.
  2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.
  3. Concrete footings shall have a neat appearance and shall be extended 2-inches above grade and troweled to a crown to shed water.
  4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.
- E. **Bracing:** Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.
1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.
- F. **Intermediate Brace Posts:** Where straight runs of fencing exceed 500-feet, intermediate brace posts shall be installed, spaced equally between ends or corners;

with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500-feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

- G. **Top Rails:** Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.
- H. **Center Rails:** Center rails shall be provided where indicated. Rails shall be installed in one piece, between posts and flush with posts on fabric side, using special offset fittings where necessary.
- I. **Tension Wire:** Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2-inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6-gauge galvanized wire.
- J. **Fabric**
  - 1. Chain-link fabric shall be fastened on the secured side of the posts.
  - 2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.
  - 3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.
- K. **Tie Wires:** Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.
  - 1. Fabric shall be tied to line posts with tie wires spaced at 12-inches on center.
  - 2. Fabric shall be tied to rails and braces with tie wires spaced at 24-inches on center.
  - 3. Fabric shall be tied to tension wires, with hog rings spaced 24-inches on center.
- L. **Stretcher Bars:** Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 15 inches on center.
- M. **Fasteners:** Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.
- N. Galvanized coating damaged during construction of the fencing shall be repaired by application of **Galvo-Weld**; **Galvinox**; or equal.

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## SECTION 33 37 36 – HYDRODYNAMIC SEPARATORS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide hydrodynamic separators and appurtenant WORK, complete and operable, in accordance with the Contract Documents.
- B. **Single Manufacturer:** Hydrodynamic separators and all housings, accessories, fastenings, and attachments shall be products of a single manufacturer.
- C. The manufacturer of the hydrodynamic separators shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the ENGINEER.

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

- A. The following is a list of standards which may be referenced in this section:

ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 320	Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A 497	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 150	Standard Specification for Portland Cement
ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 857	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C 858	Standard Specification for Underground Precast Concrete Utility Structures
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

ASTM D 4097                      Standard Specification for Contact-Molded Glass-Fiber-Reinforced  
Thermoset Resin Corrosion Resistant Tanks

ASTM F 1267-01                Standard Specification for Metal, Expanded, Steel

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Shop Drawings: CONTRACTOR shall submit shop drawings of all connections to the hydrodynamic separator
- C. Manufacturer's Literature: CONTRACTOR shall submit manufacturer's literature for the product being proposed, including operation manuals, manufacturer's product plans, and any other supporting literature.
- D. Calculations: CONTRACTOR shall submit any supporting calculations used in the sizing of or selection of the hydrodynamic separator.
- E. Manufacturer's Certification: The hydrodynamic separator manufacturer shall submit to the ENGINEER a "Manufacturer's Performance Certification" certifying that each hydrodynamic separator is capable of achieving the specified removal efficiencies listed in these specifications. The certification shall be supported by independent third-party research.

### 1.4 QUALITY ASSURANCE

- A. All components shall be subject to inspection by the ENGINEER at the place of manufacture and/or installation. All components are subject to being rejected or identified for repair if the quality of materials and manufacturing do not comply with the requirements of this specification. Components which have been identified as defective may be subject for repair where final acceptance of the component is contingent on the discretion of the ENGINEER.
- B. The manufacturer shall guarantee the hydrodynamic separator components against all manufacturer originated defects in materials or workmanship for a period of twelve (12) months from the date the components are delivered to the OWNER for installation. The manufacturer shall upon its determination repair, correct, or replace any manufacturer originated defects advised in writing to the manufacturer within the referenced warranty period.

## PART 2 -- PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. The hydrodynamic separator shall be sized to either achieve an 80 percent average annual reduction in the total suspended solid load with a particle size distribution having a mean particle size ( $D_{50}$ ) of 125 microns unless otherwise stated.
- B. The hydrodynamic separator shall be capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 millimeters (mm) regardless of the pollutant's

specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the devices rated treatment capacity. The device shall be designed to retain all previously captured pollutants addressed by this subsection under all flow conditions.

- C. The hydrodynamic separator shall be capable of capturing and retaining total petroleum hydrocarbons. The hydrodynamic separator shall be capable of achieving a removal efficiency of 92 and 78 percent when the device is operating at 25 and 50 percent of its rated treatment capacity, respectively. These removal efficiencies shall be based on independent third-party research for influent oil concentrations representative of storm water runoff (20 +/- 5 mg/L). The hydrodynamic separator shall be greater than 99 percent effective in controlling dry-weather accidental oil spills.
- D. The hydrodynamic separator shall be designed with a sump chamber for the storage of captured sediments and other negatively buoyant pollutants in between maintenance cycles. The minimum storage capacity provided by the sump chamber shall be in accordance with the indicated dimensions on the Contract Drawings. The boundaries of the sump chamber shall be limited to that which do not degrade the hydrodynamic separator's treatment efficiency as captured pollutants accumulate. The sump chamber shall be separate from the treatment processing portion(s) of the hydrodynamic separator to minimize the probability of fine particle re-suspension.
- E. In order to not restrict the OWNER's ability to maintain the hydrodynamic separator, the minimum dimension providing access from the ground surface to the sump chamber shall be 16 inches in diameter.
- F. The hydrodynamic separator shall convey the flow from the peak storm event of the drainage network, as defined below. If a substitute hydrodynamic separator is proposed, supporting documentation shall be submitted that demonstrates equal or better upstream hydraulic conditions compared to that specified herein. This documentation shall be signed and sealed by a Professional Engineer registered in the State of California. All costs associated with preparing and certifying this documentation shall be born solely by the CONTRACTOR.
- G. The hydrodynamic separator shall be designed to meet the California Statewide Trash Amendments Full Capture System requirements.

## 2.2 DESIGN PARAMETERS

- A. The hydrodynamic separator design shall be based on the design parameters in the following table:

Design Parameter	North Hatchery Hydrodynamic Separator (HDS1)	South Hatchery Hydrodynamic Separator (HDS2)
Trash Screening Required	Yes	Yes
Treatment Flow Rate (cfs)	0.33	0.36
Peak Flow Rate (cfs)	2.70	2.78



TSS Removal Efficiency (%)	80	80
Pipe Configuration	As indicated in plans	

## 2.3 CONCRETE STRUCTURE

- A. Housing unit of hydrodynamic separator device shall be constructed of pre-cast or cast-in-place concrete, no exceptions. Precast concrete components shall conform to applicable sections of ASTM C478, ASTM C857, and ASTM C858 and the following:
1. Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);
  2. Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;
  3. Cement shall be Type III Portland Cement conforming to ASTM C150;
  4. Aggregates shall conform to ASTM C33;
  5. Reinforcing steel shall be deformed billet-steel bars, welded steel wire, or deformed welded steel wire conforming to ASTM A615, A185, or A497;
  6. Joints shall be sealed with preformed joint sealing compound conforming to ASTM C990;
  7. Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

## 2.4 INTERNAL COMPONENTS

- A. Screen and support structure shall be manufactured of Type 316 and 316L stainless steel conforming to ASTM F1267-01;
- B. Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A320;
- C. Fiberglass components shall conform to applicable sections of ASTM D4097;

## 2.5 MANHOLE COMPONENTS

- A. Manhole castings shall be designed to withstand AASHTO H-20 loadings and manufactured of cast iron conforming to ASTM A 48 Class 30.

## 2.6 MANUFACTURERS AND MODEL, OR EQUAL

- A. **Contech Engineered Solutions, CDS 1515-3-C**

## **PART 3 -- EXECUTION**

### **3.1 STORAGE/ACCEPTANCE**

- A. The CONTRACTOR shall exercise care in the storage and handling of the hydrodynamic separator components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be born by the CONTRACTOR.

### **3.2 INSTALLATION**

- A. CONTRACTOR shall overexcavate 18 inches below the bottom elevation of the concrete structure, and shall backfill and compact with Type SF structural fill material in accordance with the requirements of Specification 31 00 00.
- B. The hydrodynamic separator shall be installed in accordance with the manufacturer's recommendations and related sections of the Contract Documents. The manufacturer shall provide the CONTRACTOR installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.
- C. The CONTRACTOR shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The CONTRACTOR shall trim all protruding lifting provisions flush with the adjacent concrete surface in a manner which leaves no sharp points or edges.
- D. The CONTRACTOR shall remove all loose material and pooling water from the hydrodynamic separator prior to the transfer of operational responsibility to the OWNER.

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## **SECTION 35 79 13 - TRAVELING BELT INTAKE SCREEN**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide traveling belt fish screens and appurtenances, electronic control system, complete and operable, in accordance with the Contract Documents.

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

- A. The following is a list of standards which may be referenced in this section:

##### **American Society for Testing and Materials (ASTM)**

A36/A36M      Standard Specification for Carbon Structural Steel

A240/240M      Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

##### **National Fire Protection Association (NFPA)**

70              National Electrical Code (NEC)

##### **Underwriters Laboratories, Inc. (UL)**

489              Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

508              Standard for Industrial Control Equipment

508A            Standard for Industrial Control Panels

1063            Standard for Machine-Tool Wires and Cables

#### **1.3 RELATED SECTIONS**

- A. Section 40 90 18 – Vendor Package Control Systems

#### **1.4 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

1. Submit schematic and elementary diagrams for control cabinet.
2. Submit power and control interconnection drawings.
3. Submit product data for programmable logic controller (PLC).

- B. Shop Drawings:

1. Complete fabrication, assembly, foundation and installation drawings, together with detailed specifications and data covering material used, power drive assembly, parts, devices and other accessories forming a part of the equipment.

2. Submit control cabinet enclosure shop drawings, showing internal and external arrangements with enumerated bill of materials detailing manufacturers and part numbers for each item.

C. Technical Manuals:

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

## 1.5 QUALITY ASSURANCE

- A. The CONTRACTOR shall furnish the services of a trained, qualified manufacturer's representative for not less than 2 Days to assist, check, and approve the installation and start up the equipment and instruct the OWNER's operational personnel.

## PART 2 -- PRODUCTS

### 2.1 EQUIPMENT REQUIREMENTS

- A. **General:** The CONTRACTOR shall provide a vertical traveling fish screen to remove debris and protect fish. The traveling screen shall meet all applicable design criteria specified for active screen types in the National Marine Fisheries Service (NMFS) Anadromous Salmonid passage Facility Design Manual for Active screens. Debris shall be removed via spray wash at the top of the screen frame, with waste debris collected in a trough.
- B. **Construction:** The equipment shall be an automatic, self-cleaning traveling belt screen. Designs shall be such that maintenance to the mechanisms such as motors, drives, and bearings can be accomplished at the operating floor level without the use of access ladders or by dewatering the channel. The belts shall be the only moving parts to become submerged.
- C. The equipment shall be readily adaptable for installation and operation in the structure indicated. If equipment which requires a change or modification of the design indicated is submitted and accepted, the CONTRACTOR shall prepare and submit for approval drawings showing the necessary changes. Such changes shall be made at the CONTRACTOR's own expense and shall include mechanical, structural, and electrical WORK.
- D. **Capacity:** The traveling belt screens shall be designed based on the following technical criteria:

Number of screens	2
Channel width per screen, in	36
Invert Elevation, ft msl	2506.3

Platform Elevation, ft msl	2512.9
Design flow, cfs per screen	5
Maximum upstream WSL, ft msl	2511.0

- E. **Stainless Steel Bolts:** Bolts, anchor bolts, and washers which are submerged or below the top of the wall inside any hydraulic structure shall be of Type 316 stainless steel, with bronze nuts or cap screws of copper-silicon alloy, conforming to Section 05 55 00 - Miscellaneous Metalwork. Wherever stainless-steel bolts and nuts are indicated, it shall refer to the above material combination, unless specifically excluded.
- F. **Anchors:** Unless otherwise indicated, anchors shall be in accordance with Section 05 55 00 – Miscellaneous Metalwork. Submerged anchors shall be Type 316 stainless steel.
- G. The CONTRACTOR shall have the manufacturer supply the initial lubrication and necessary sealing fluids.

## 2.2 TRAVELING BELT SCREEN

- A. The Traveling Belt Screens shall consist of a 12-gauge 316 stainless steel wire screening media belt with 1" square openings, including side frames, guide rollers, cog wheels, drive components, heavy-duty hydraulic shock absorbers, and spray wash system.
- B. The Traveling Belt Screens shall be capable of supporting a maximum head differential of 3 feet across the screen.
- C. The main reduction ratio of the drive motor shall accomplish a final screen travel speed of approximately 9-10 feet per minute. Provision for screen tension adjustment shall be included. All drive components shall be designed to withstand the full NEMA stalling torque of the motor without damage to any part of the drive components.
- D. **Frames:** The traveling screen framing system shall be of mild steel construction with coating in accordance with **System 50** as described in Section 09 96 00, suitably reinforced to support loads imposed on the mechanism during operation, installation, assembly or transportation. The frame shall be securely fastened to the slot provided by the Contractor.
- E. **Debris Trough:** A debris trough shall be provided on the intake grating platform immediately behind the traveling screens to collect debris removed from the screens during operation.
- F. **Operation:** Debris shall be removed from the belt screen by a high-pressure spray wash located at the top of the frame.
- G. **Screening Discharge:** The belt shall be guided over the debris trough and the accumulated debris shall be removed by the spray wash to provide efficient cleaning of the belt.

- H. **Safety Guards and Inspection Covers:** The center portion of the front, upstream, side of the bar screen shall be protected by the gear rack support plate. Easily removable hinged wire mesh guards shall be included to cover the openings between the support plate and the side frames. The side frames and front plate shall have covered openings for easy access to the guide rollers, reducer, and pinion gear.

## 2.3 MOTORS

- A. Each motor shall be provided in accordance with Section 26 05 10 – Low-Voltage AC Electric Motors.
- B. Each motor shall be a premium efficiency, TEFC heavy-duty type, 1.15 service factor, and suitable for 480 volt, three-phase, 60 Hz supply at maximum speed. Dual voltage motors are acceptable.
- C. Each motor shall be sized to continuously carry the maximum load that develops across the full range of operation, and a minimum of 1 hp for screen motors and 1-1/2 hp for spray wash pumps, and it shall be direct connected to a gear reducer.
- D. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the WORK.

## 2.4 CONTROL SYSTEM

- A. The control panel and all related control components shall be provided in accordance with the requirements of Sections 40 90 18 – Vendor Package Control Systems and 40 90 05 – Control Enclosures and Devices.
- B. Provide the following control system components, at a minimum:
  - 1. Provide a compact, modular microcontroller and input/output modules as required for a complete and operable system.
  - 2. Uninterruptible power supply (UPS) in the control panel that supplies a minimum of 15 minutes of backup power to the control panel during loss of power to the panel. UPS shall be sized to supply the PLC and all control logic, but not the traveling screen or spray wash pump motors.
  - 3. Surge protective devices as necessary to protect the PLC, level sensors, and other electronic devices in the control panel.
  - 4. Motor starters, motor disconnects, and motor protection inside the control panel as required, and in accordance with the applicable sections of NFPA 70.
  - 5. Indicating lights for “Power On”, “High Water Differential”, and “General Alarm”.
  - 6. Hand/Off/Auto mode selector switch.
  - 7. Emergency stop pushbutton, push-pull type.
- C. **Operational Criteria:**

1. When Hand/Off/Auto switch is in "Hand" mode, the traveling screen shall operate continuously.
2. When in "Off" mode, the traveling screen shall cease operation.
3. When in "Auto" mode, the traveling screen shall operate in accordance with the following criteria:
  - a. The traveling screen control system shall be capable of continuous automatic operation when the water differential across the screen (measured by two level sensors provided by others) exceeds the high water differential setpoint, factory set at 0.1 feet of head, until the water differential is measured to be less than the setpoint.
  - b. The traveling screen shall also operate at least once every five minutes for at least one full screen rotation (interval between operations and duration of operation shall be easily field-adjustable).
  - c. Head water differential operation shall take priority in "Auto" mode. No other operational criteria beyond the previous requirements are required.
- D. At a minimum, provide one dry, normally open contact for "General Alarm", rated 5A at 120 Vac, for remote indication. An unresolved high-water differential condition shall actuate and latch the alarm after the system senses continuous high-water differential for at least 5 minutes, adjustable.
- E. Provide two 4-20 mA analog output signals to indicate level signals remotely.
- F. **Machine Mounted Devices:** Devices, such as limit switches, photocells, and proximity switches, that are deemed necessary for machine control and product handling, shall be mounted, pre-wired, and terminated in junction boxes. Devices shall be mounted on adjustable brackets and each will be tagged with an identifying number to coincide with the electrical schematics.
- G. The PLC program shall be tested with the actual equipment by the MANUFACTURER prior to shipment, then the PLC program shall be tested again and verified at Site of installation during startup. PLC licenses and software shall transfer to the OWNER after final acceptance of the traveling screen system.

## 2.5 SPRAY WASH SYSTEM

- A. Provide a spray wash pump per traveling screen, intended for debris removal and self-cleaning.
- B. Spray wash pumps shall include foot valve and be able to lift water up to 15-ft prior to pressure boosting.
- C. The suction and discharge piping of the spray wash system shall be laid out by the CONTRACTOR in accordance with the manufacturers recommendations. Provisions shall



be provided to allow for priming of the pump suction line as required during periodic maintenance, startup, and commissioning.

- D. A special waterproof connection is required to connect motor to power cable. A manually cleaned wash water filter shall be provided similar to Yardney Model SF 6-40
- E. Refer to Section 44 35 35 for specifications on the spray pumps.

## 2.6 TOOLS AND SPARE PARTS

- A. **Tools:** The CONTRACTOR shall supply one complete set of special wrenches or other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright, finished heads and with work faces dressed to fit nuts. The set of tools shall be furnished in a labeled toolbox of suitable design provided with a hinged cover.
- B. **Spare Parts:** The CONTRACTOR shall furnish one set of spare parts for components exposed to operational wear during normal equipment service. Spare parts shall include bearings, sprockets, chains, pinions, limit switches, drive gear rack, rollers, and wiper blades.

## 2.7 MANUFACTURERS, OR EQUAL

- A. **International Water Screens (IWS)**
- B. **Hydrolox.**

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. Installation of the traveling belt screen shall be in strict accordance with the requirements of the manufacturer's written instructions and Shop Drawings.
- B. Parts of the mechanism shall be amply proportioned for stresses that may occur during fabrication, erection, and intermittent or continuous operation. Workmanship shall be of high grade and be of the latest design.

### 3.2 FIELD TESTING

- A. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation without excessive noise, vibration, overheating, etc. Equipment shall be adjusted and checked for alignment, clearances, supports, and adherence to safety standards, until found satisfactory.

- END OF SECTION -

## SECTION 40 05 67 – HYDRAULIC CYLINDERS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide a new hydraulic cylinder for raising and lowering the existing electro-anesthesia tank, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Shop Drawing information and technical details for the cylinder shall be submitted for approval.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. **Cylinder Mounting and Position Indicators:** Hydraulic cylinders shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength.
- B. Fasteners shall be in accordance with Section 05 55 00 - Miscellaneous Metalwork.
- C. Protective coatings shall be in accordance with Section 09 96 00 - Protective Coatings.

#### 2.2 HYDRAULIC CYLINDERS

- A. **Equipment Requirements:** The hydraulic cylinder rod shall be affixed to the existing electro-anesthesia tank frame and is intended to raise and lower the tank as required for hatchery operations.
- B. **Hydraulic Power:** The hydraulic cylinder shall be connected to the existing hydraulic pump and power source, providing hydraulic fluid at 1,000 psi at a flow rate of 2.8 gpm.
- C. **Hydraulic Fluid:** Cylinder shall use a mineral-based or petroleum-based oil with a viscosity of 18.2 centistokes to 35 centistokes at 100 degrees F at a pressure of 14 MPa (2,000 psi). The manufacturer shall submit with the Shop Drawings a statement in writing that wetted parts of the hydraulic system are suitable for extended operation with the hydraulic fluid. Hydraulic fluid with antifoam, anti-wear, rust prevention and water separating characteristics suitable for the service are desirable.
- D. **Hydraulic Cylinder**
  - 1. Construction: The hydraulic cylinder shall be double acting; of alloy steel, precision-machined, bored, and honed to a micro-finish of 0.5  $\mu$ m or better and coated against a corrosive environment. The cylinder shall be supported on a heavy steel or cast iron

base plate. The heads and piston shall be of carbon steel with Teflon wearing rings for the piston. The piston rod shall be of alloy steel with a micro-finish and hard chrome-plated, running in over-sized bronze bearings. Seals shall be Buna-N or Viton. The adaption spool shall be a single piece, flanged steel unit with an access door. Adjustable open- and closed-travel stops shall be provided.

2. Manufacturers, or equal

a. Parker Model 2.50JB3LLUxxx75.000

Piston rod diameter and end connection style shall be verified by the CONTRACTOR to match the electro-anesthesia tank lifting socket.

3. Each hydraulic cylinder shall be furnished with adjustable limit switches at fully open and fully closed positions.

4. Spare Parts and Supplies

a. Spare Parts: Furnish the following:

2 sets of packing, gaskets, O-rings, and seals

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. Hydraulic cylinder shall be installed in accordance with the manufacturer's written instructions and as indicated on the Contract documents.

### **3.2 TESTING**

- A. CONTRACTOR shall operationally test the hydraulic cylinder during Commissioning, to be approved by the OWNER and ENGINEER
1. Operate the hydraulic cylinder in both directions at full working pressure and rated flow.
  2. Verify actuation of upper and lower limit switches at extents of required travel for electro-anesthesia tank operation.

- END OF SECTION -

## SECTION 40 23 00 - PIPING, GENERAL

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide the piping systems indicated, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all piping sections.
- C. The mechanical Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical Drawings are **not** pipe construction or fabrication drawings. Where pipe supports and spacing are indicated on the Drawings and are referenced to a Standard Detail, the CONTRACTOR shall use that Detail. Where pipe supports are not indicated on the Drawings, **it is the CONTRACTOR's responsibility to develop the details necessary to design and construct mechanical piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.**

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings:** Shop Drawings shall contain the following information:
  - 1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.
  - 2. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.
  - 3. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.
  - 4. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.
- C. **Samples:** Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR's responsibility.
- D. Certifications
  - 1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricator's or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. **Extent of Work:** Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections and as indicated. Materials in contact with potable water shall be listed as compliant with NSF Standard 61.
- B. **Pipe Supports:** Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 23 02 - Pipe Supports, and as indicated. Supports shall resist stresses created by specified maximum seismic load from Project General Conditions
- C. **Lining:** Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections unless otherwise indicated.
- D. **Coating:** Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections unless otherwise indicated. Pipes above ground or in structures shall be coated in accordance with Section 09 96 00 - Protective Coatings.
- E. **Pressure Rating:** Piping systems shall be designed for the maximum expected pressure as indicated on the Piping Schedule.
- F. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. During the manufacture, the ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.
- G. **Tests:** Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. The CONTRACTOR shall be responsible for performing material tests.
- H. **Welding Requirements:** Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 – Structural Welding Code. Welding procedures shall be submitted for the ENGINEER's review.
- I. **Welder Qualifications:** Welding shall be done by skilled welders and welding operators who have adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, by an independent local, approved testing agency not more than 6 months prior to commencing WORK on the piping. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. Qualification testing of welders and materials used during testing is part of the WORK.

### 2.2 PIPE FLANGES

- A. **General:** Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated. Attachment of the flanges to the pipe

shall conform to the applicable requirements of AWWA C207. Flange faces shall be perpendicular to the axis of the adjoining pipe. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for these pipes.

B. Pressure Ratings

1. Flanges shall conform to either AWWA C207 – Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 – Pipe Flanges and Flanged Fittings, 150 lb class.

C. **Blind Flanges:** Blind flanges shall be in accordance with AWWA C207, or as indicated for miscellaneous small pipes. Blind flanges for pipe sizes 12-inches and greater shall be provided with lifting eyes in the form of welded or screwed eye bolts.

D. **Flange Coating:** Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. **Flange Bolts:** Bolts and nuts shall conform to Section 05 55 00 – Miscellaneous Metalwork. All-thread studs shall be used on valve flange connections where space restrictions preclude the use of regular bolts.

F. **Insulating Flanges:** Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.

G. **Insulating Flange Sets:** Insulating flange sets shall be provided where indicated. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material. Steel washers shall be in accordance with ASTM A325 – Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength. Insulating gaskets shall be full-face.

H. Insulating flange manufacturers, or equal

1. **JM Red Devil, Type E**
2. **Maloney Pipeline Products Co.**
3. **PSI Products, Inc.**

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full-faced type, with material and thickness in accordance with AWWA C207, suitable for temperatures to 700 deg F, a pH of one to 11, and pressures to 1000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted unless otherwise indicated. Flange gaskets shall be as manufactured by **John Crane, Style 2160, Garlock, Style 3000**, or equal.

2. Gaskets for flanged joints used in water with chloramines shall be **Gylon, Style 3500** as manufactured by **Garlock**, or equal.
3. Gaskets for flanges for PVC and CPVC piping used in general water and wastewater service shall be full faced, 1/8-inch thick, made of ethylene propylene rubber (EPR) having a Type A durometer hardness of 50 to 70 when tested in accordance with ASTM D 2240. When the mating flange has a raised face, provide a flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

## 2.3 THREADED INSULATING CONNECTIONS

- A. **General:** Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. **Materials:** Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

## 2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. **General:** Cast mechanical-type couplings shall be provided where indicated. The couplings shall conform to the requirements of AWWA C606 - Grooved and Shouldered Joints. Bolts and nuts shall conform to the requirements of Section 05 50 00. Gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of grooved piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid excessive load on equipment caused by pipe movement due to steady state or transient pressure conditions, equipment connections with mechanical-type couplings shall have rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means. Mechanical type couplings shall be bonded. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling. Grooving tools shall be from the same manufacturer as the grooved components.
- B. Manufacturers of ductile iron pipe couplings, or equal
  1. **Gustin-Bacon, (Aeroquip Corp.)**
  2. **Victaulic Style 31** (flexible or rigid grooving)

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

- C. Manufacturers of couplings for PVC pipe, or equal
  1. **Gustin-Bacon, (Aeroquip Corp.)**

## 2. Victaulic Style 775

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

### 2.5 SLEEVE–SPLIT TYPE COUPLINGS (**Depend-O-Lok**)

- A. **General:** Where indicated sleeve-split type couplings shall be furnished.
- B. **Construction:** Couplings shall be split-type, consisting of one or 2-piece housing, gasket assembly, bolts and nuts, and end rings. The double arch cross section that closes around the pipe ends shall be smooth to allow for expansion or contraction requirements. The pipe ends with steel end rings affixed shall provide restraint requirements. As the coupling closes, it shall confine the elastomeric gasket beneath the arches of the sleeve to create a radial seal. The axial seal shall squeeze the closure plates as the bolts pull the coupling snug around the pipe. The coupling shall permit angular pipe deflection, flexibility, contraction and expansion as designed by the manufacturer. The coupling housing shall be designed for internal pressure and external loads as determined by the design procedures of AWWA M11. The coupling shell thickness of the steel coupling shall be calculated using the formula:

$$T = P_w D_y / 2 F_s \quad \text{Where:}$$

$T$  = steel coupling thickness, in.

$D_y$  = pipe outside diameter, in.

$P_w$  = Design working pressure, psi

$F_s$  = 50 percent of minimum yield point of steel, psi

1. Coupling design calculations shall be stamped and signed by a registered engineer and shall be included in the Shop Drawing submittal for couplings.
2. The sealing members shall comprise of two "O"-ring gaskets and an elastomer sealing pad bonded to sealing plate. Internal pressure shall not be required to make the seal.

#### C. Materials

1. Unless otherwise indicated, coupling housing material shall be the same material as the piping. Carbon steel couplings shall be fabricated from ASTM A36. Stainless steel couplings shall be fabricated from ASTM A240, T-304, 304L, 316, or 316L.
2. Carbon steel end rings shall conform to ASTM A108 Grade 1018. Stainless steel end rings shall conform to ASTM A276 T-316L.
3. Bolts and nuts shall be in conformance with Section 05 50 00.
4. Gaskets shall be EPDM conforming to ASTM D2000 for air service up to 240 degrees F. Gaskets for general water or sewerage service within the temperature range of – 20 to 180 degrees F shall be isoprene or EPDM conforming to ASTM D2000.



5. Carbon steel couplings shall be fusion bond epoxy coated inside and outside of the coupling in accordance with Section 09 96 00. Couplings installed underground shall be provided with **Depend-O-Wrap** tape or equal. Application of wrapping material shall be in conformance with AWWA C209.

#### D. Pipe Preparation

1. Ends of pipes shall be prepared for the flexible split sleeve type couplings inspected and approved by the coupling manufacturer. The pipe outside diameter and roundness tolerances shall comply with tolerances listed in AWWA C219.
2. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from end of the pipe.
3. End rings shall be furnished with couplings when restraint is required. Carbon steel end rings shall be ASTM A108 Grade 1018. Stainless steel end rings shall conform to ASTM A 276 T-316L.
4. Where the split-type coupling is used to take up thermal expansion or contraction (**Depend-O-Lok F X E**) at the pipe joint, one end ring shall be fixed to one end of the pipe to keep the coupling in the proper location.
5. Where the split-type coupling is used for a fully restrained pipe joint (**Depend-O-Lok F X F**) at the pipe joint, one end ring shall be welded to each of the pipe ends to fit beneath the coupling and shall be protected by the coating. Welding design and specification shall be in conformance with the coupling manufacturer's recommendation.

#### E. Manufacturer

1. **Depend-O-Lok**

### 2.6 SLEEVE-TYPE COUPLINGS

- A. **General:** Sleeve-type couplings shall be provided where indicated. The CONTRACTOR will not be allowed to substitute a sleeve-split coupling, or any other type in lieu of sleeve coupling unless approved by the ENGINEER.
- B. **Construction:** Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe. Couplings shall be steel with steel bolts, without pipe stop. Couplings shall be of sizes to fit the pipe and fittings indicated. The middle ring shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The coupling shall be either 5- or 7-inches long for sizes up to and including 30-inches and 10-inches long for sizes greater than 30-inches, for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings, and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket.

Bolts and nuts shall conform to the requirements of Section 05 50 00. Buried sleeve-type couplings shall be epoxy-coated at the factory as indicated.

- C. **Pipe Preparation:** Where indicated, the ends of the pipe shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12-inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.
- D. **Gaskets**
1. Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
    - a. Color – Jet Black
    - b. Surface – Non-blooming
    - c. Durometer Hardness – 74 plus and minus 5
    - d. Tensile Strength – 1000 psi minimum
    - e. Elongation – 175 percent minimum
  2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D2000 – Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where sleeve couplings are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.
  3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or equal.
- E. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.
- F. **Insulating Sleeve Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

G. **Restrained Joints:** Sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.

H. Manufacturers, or equal

1. **Dresser, Style 38**

2. **Ford Meter Box Co., Inc., Style FC1 or FC3**

3. **Smith-Blair, Style 411**

## 2.7 FLANGE COUPLING ADAPTERS

A. Flange coupling adapters shall be provided where indicated. The CONTRACTOR will not be allowed to substitute any other type in lieu of flange coupling adapter unless approved by the ENGINEER. The coupling shall be rated as indicated.

B. **Construction:** Flange coupling adapter body shall be fabricated from steel ASTM A512 – Cold-Drawn Buttweld Carbon Steel Mechanical Tubing or A513 – Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing with steel bolts, without pipe stop. Flange shall be in accordance with AWWA C207. Couplings shall be of sizes to fit the pipe and fittings indicated. The body shall be not less than 1/4-inch thick or at least the same wall thickness as the pipe to which the coupling is connected. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe. The follower flange shall be fabricated from steel, ASTM A576 – Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Flange coupling adapters installed in piping system rated for positive pressure, the coupling shall be restrained with harness bolts or tie rods. Other means of restraining the coupling such as set screws will not be acceptable. Bolts and nuts shall conform to the requirements of Section 05 50 00. Buried couplings shall be epoxy-coated at the factory as indicated.

C. **Gaskets:** Gaskets for flange coupling adapters shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," Grade 60 NSF approved, or equivalent suitable elastomer.

1. The rubber in the gasket shall meet the following specifications:

a. Color – Jet Black

b. Surface – Non-blooming

c. Durometer Hardness – 74 plus and minus 5

- d. Tensile Strength – 1000 psi Minimum
  - e. Elongation – 175 percent Minimum
- 2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. Gaskets shall meet the requirements of ASTM D2000 – Classification System for Rubber Products in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. Where flange coupling adapters are used in water containing chloramine or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.
  - 3. Gasket materials used in water with chloramines shall be **Gylon Style 3500** by **Garlock** or equal.
- D. **Piping Connection to Equipment:** Where piping connects to mechanical equipment such as pumps, compressors, and blowers, the piping shall be brought to the equipment connection aligned and perpendicular to the axis of the flange or fitting for which the piping is to be connected. The piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment. The CONTRACTOR shall assign the responsibility to the equipment manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.
- E. **Restrained Joints:** Flange coupling adapters on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation to prevent misalignment of the pump imparted by the thrust within the piping system.
- F. Manufacturers, or Equal
- 1. **Smith-Blair, Model 975**
  - 2. **JCM, Model 309**
- 2.8 FLEXIBLE CONNECTORS
- A. **Low Temperatures:** Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated. Flexible connectors for service temperatures up to 180 deg F shall be flanged reinforced neoprene or butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 deg F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise indicated. The connectors shall be a minimum of 9-inches long, face-to-face flanges, unless otherwise indicated. The final material selection shall be approved by the manufacturer. The CONTRACTOR shall submit Shop Drawings and calculations.
- B. **High Temperature:** Flexible connectors shall be installed in engine exhaust piping and where indicated. Connectors shall be sufficient to compensate for thermal expansion and

contraction and also to isolate vibration between the engine and the exhaust piping system. Connectors shall be stainless steel bellows type, flanged, and rated for minimum 150 psi, 2000 deg F.

## 2.9 EXPANSION JOINTS

- A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be flanged end, stainless steel, Monel, rubber, or other materials best suited for each individual service. The CONTRACTOR shall submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.

## 2.10 PIPE THREADS

- A. Pipe threads shall be in accordance with ASME B1.20.1 – Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

## 2.11 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

- A. Where indicated and where required to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 deg F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening. Links shall be assembled with type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.
- B. Manufacturers, or equal

### 1. Thunderline Corporation, Link-Seal

## PART 3 -- EXECUTION

### 3.1 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact. Defective or damaged materials shall be replaced with new materials.

### 3.2 GENERAL

- A. Piping, fittings, and appurtenances shall be installed in accordance with the requirements of applicable Sections of Division 2 and Division 15. Proprietary manufactured couplings shall be installed in accordance with the coupling manufacturer's recommendation.

- B. Care shall be taken to ensure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:
1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Each gasket shall be centered properly on the contact surfaces.
  2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.
  3. Bolts shall be initially hand-tightened with the piping connections properly aligned. Bolts shall be tightened with a torque wrench in a staggered sequence to the AISC recommended torque for the bolt material.
  4. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove.
  5. After installation, joints shall meet the indicated leakage rate. Flanges shall not be deformed nor cracked.
- C. **Lined Piping Systems:** The lining manufacturer shall take full responsibility for the complete, final product and its application. Pipe ends and joints of lined pipes at screwed flanges shall be epoxy-coated to assure continuous protection.
- D. **Core Drilling:** Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and reinforcing bars.
- E. **Cleanup:** After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be handed over in a clean and functional condition.

- END OF SECTION -

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## SECTION 40 23 01 - PIPING IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide identification for exposed piping and valves, complete and in place, in accordance with the Contract Documents.

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

- A. Commercial Standards

ANSI A13.1                      Scheme for the Identification of Piping Systems

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings:** A list of suggested wording for each valve tag, prior to fabrication.
- C. Samples
  - 1. One sample of each type of identification device.
  - 2. Sample of each proposed color required by the pipe color schedule.

### PART 2 -- PRODUCTS

#### 2.1 IDENTIFICATION OF PIPING

- A. Except as indicated below for very short pipe lengths, identify exposed piping larger than 2-inches nominal size for the pipe contents and direction of flow.
  - 1. Marker Type
    - a. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.
  - 2. Marker Area: Sized per pipe size according to ANSI A13.1; color from the table below.
  - 3. Lettering: Sized per pipe size according to ANSI A13.1; color from the table below.
  - 4. Arrows: at least 2 arrows at each marker area, showing direction of flow.
- B. Pipe 2-inches and smaller shall be identified by plastic plates made from laminated 3-layer plastic with engraved black letters on white background.
- C. Pipe identification shall be as manufactured by **Brady, Seton**, or equal.



## 2.2 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the indicated system.

## 2.3 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.
- B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid plastic laminate with embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.
- C. Wording on the valve tags shall describe the exact function of each valve, e.g., "RW-SUPPLY", "WD-RETURN", etc.

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

### 3.2 VALVE TAGS

- A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

### 3.3 MARKER LOCATIONS

- A. Each pipe shall be marked at:
  - 1. Intervals of 20-feet in straight runs.
  - 2. At least once in every room.
  - 3. Within 2-feet of turns, elbows, and valves.
  - 4. On the upstream side of tees, branches, and other distribution points.
  - 5. On both sides of walls and floors through which the piping passes.

### 3.4 IDENTIFICATION COLORS

- A. Conform to the following color codes.

Color Schedule				
Pipe Contents		Pipe Color	Marker Color	Letter Color
Abbreviation	Identification			
DR	Drain		green	white
FR	Fish Return		green	white
RW	Raw Water		yellow	black
UW	Utility water (non-potable water)		yellow	black
WD	Waste Drain		green	white

- END OF SECTION -

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## **SECTION 40 23 02 - PIPE SUPPORTS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. Provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.
- B. Where pipe support systems are not indicated on the Drawings, the CONTRACTOR shall design and provide the supports in accordance with this Section.
- C. Seismic and Wind Forces
  - 1. Pipe support details indicated in the Contract Drawings are not designed to resist seismic and wind forces.
  - 2. The CONTRACTOR shall arrange for the services of a registered professional engineer experienced in pipe support design to design such pipe supports.
  - 3. The CONTRACTOR shall provide additional supports as needed to resist such forces.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Shop Drawings
  - 1. Submit Shop Drawings which shall include the following information:
    - a. Drawings of pipe supports, hangers, anchors, and guides
    - b. Calculations for special supports and anchors, stamped and signed by a registered professional engineer.

### **PART 2 -- PRODUCTS**

#### **2.1 GENERAL REQUIREMENTS**

- A. Code Compliance
  - 1. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, probable forces applied during construction, and stresses on piping, equipment, and structures.
  - 2. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

#### B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.
2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR.
3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction, and shall be as acceptable to the ENGINEER.

#### C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping and preventing excessive stress on equipment.
2. Hangers shall have a means of vertical adjustment after erection.
3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.
4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.
5. Hanger rods shall be subjected to vertical loading only.

#### D. Hangers Subject to Horizontal Movements

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.
2. Where horizontal pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

#### E. Spring-Type Hangers

1. Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping.
2. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered.
3. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate the compression of the spring.

4. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

#### F. Thermal Expansion

1. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or expansion joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely away from the anchored points.
2. Components shall be structurally suitable to withstand the imposed loads.

#### G. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

#### H. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.
2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

#### I. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.
2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

#### J. Concrete Anchors

1. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table; consult the ENGINEER for any anchor applications not appearing on the table.
2. Anchor embedment shall be in accordance with the requirements of Section 05 50 00 – Metal Fabrications & Miscellaneous Metals.

Pipe Support Application	Type of Concrete Anchor
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use <b>Grinnell (Anvil International), Tolco</b> , or equal.

Existing Concrete	Use non-shrink grouted anchors, metallic type expansion anchors, or epoxy anchors.  Exceptions: Metallic type expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100 deg F or higher than the limiting temperature recommended by the manufacturer. Epoxy anchors are not accepted where anchors are subject to vibration or fire.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors

## 2.2 SUPPORT SPACING

- A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.
- B. Pipe support spacing shall not exceed the maximum indicated spans.
- C. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.
- D. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.
- E. Ductile Iron Pipe
  - 1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.
  - 2. As a minimum, where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
ALL DIAMETERS	two supports per pipe length, with one of the two supports located at a joint

- F. Schedule 80 PVC Pipe

1. Install supports for Schedule 80 PVC pipe as indicated in the following schedule:

Support Spacing for Schedule 40 PVC Pipe <sup>1</sup>			
Nominal Pipe Size, inches	Maximum Support Spacing, feet, at Various Temperatures		
	60 deg F	100 deg F	140 deg F
1	5	4	NA
1-1/2	5.75	5.25	NA
2	6.5	5.75	NA
3	8	7	NA
4	9	8.5	NA
6	10	10	NA
8	13	11.75	NA
10	15	13	NA
12	13	14.5	NA
14	15	15	NA

<sup>1</sup> Reference: USACE based on Harvel Plastics Product Bulletin 112/401 (rev, 10/1/95), p. 63; spacing values based on test data developed by the manufacturer for the specific product and continuous spans; the piping is insulated and full of liquid with a specific gravity of 1.0

## 2.3 MANUFACTURED SUPPORTS

### G. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.
2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

### H. Manufacturers, or Equal

1. **Basic Engineers Inc.**
2. **Bergen-Paterson Pipe Support Corp.**
3. **Grinnell Corp. (Anvil International)**



4. **NPS Products, Inc.**
5. **Power Piping Company**
6. **Tolco Incorporated**

## 2.4 COATING

### I. Other Coatings

1. Other than stainless steel or non-ferrous supports, supports shall receive protective coatings in accordance with the requirements of Section 09 96 00 – Protective Coating.

## **PART 3 -- EXECUTION**

### 3.1 INSTALLATION

#### J. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 – Power Piping.
2. Concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

#### K. Appearance

1. Pipe supports and hangers shall be positioned to produce an orderly, neat piping system.
2. Hanger rods shall be vertical, without offsets.
3. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, and without interference with other WORK.

### 3.2 FABRICATION

#### L. Quality Control

1. Pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.
2. Fabricated supports shall be neat in appearance without sharp corners, burrs, or edges.

- END OF SECTION -

## SECTION 40 23 15 - STEEL PIPE (ASTM A53 / A106, MODIFIED)

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.
- B. The requirements of Section 40 23 00 - Piping, General apply to the WORK of this Section.
- C. **Pipe Material Group No. 2.** The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G-009 as Piping Material Group No. 2.

### PART 2 -- PRODUCTS

#### 2.1 PIPE MATERIAL

- A. **Water, Air, Fuel Gas, Oil, Steam, and Waste Service:** Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40 or 80, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

#### 2.2 PIPE JOINTS

- A. Galvanized steel pipe shall have screwed ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.
- B. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

#### 2.3 FITTINGS

- A. **Common Use:** The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:
  - 1. Threaded malleable iron fittings conforming to ASME B 16.3 - Malleable-Iron Threaded Fittings, Classes 150 and 300.
  - 2. Threaded cast iron fittings conforming to ASME B 16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
  - 3. Forged steel socket welded fittings conforming to ASME B 16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.
5. Threaded cast iron drainage fittings conforming to ASME 16.12 - Cast Iron Threaded Drainage Fittings.
6. Flanged cast iron fittings conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
7. Flanged steel fittings conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
8. Grooved ductile iron fittings with grooving dimensions conforming to AWWA C 606 - Joints, Grooved and Shouldered Type.
9. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. **General:** Pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be free from defects.
- B. **Supports and Anchors:** Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 23 02 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

### **3.2 PIPE PREPARATION**

- A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. Fittings shall be equally cleaned before assemblage.

### **3.3 PIPE JOINTS**

- A. **Threaded Joints:** Pipe threads shall conform to ASME B 1.20.1 - Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.
- B. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders per Section 40 23 00 - Piping, General.

- C. **Grooved Joints:** Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conform to AWWA C 606. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.
- D. **Push On Joints:** Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

### 3.4 INSPECTION AND FIELD TESTING

- A. **Inspection:** Finished installations shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Any damage shall be repaired.
- B. **Field Testing:** Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than one hour without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements, refer to Section 01 74 30 - Pressure Pipe Testing and Disinfection.
  - 1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
  - 2. After completion of the pressure tests, chlorine gas piping shall be tested for leakage using chlorine gas under operating pressures. Piping shall be thoroughly clean and dry before admitting chlorine gas into the system. Chlorine shall be slowly admitted to the piping system. Leakage shall be checked with a swab soaked in aqua ammonia solution and waved in the vicinity of each fitting. Ammonia solution shall not be applied to the fittings. Formation of white fumes will be evidence of leaks. Chlorine gas shall be purged from the line before leaks are repaired.
  - 3. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

- END OF SECTION -

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## SECTION 40 23 16 - STAINLESS STEEL PIPE (ASTM A312, MODIFIED)

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide stainless steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.
- B. The requirements of Section 40 23 00 - Piping, General apply to the WORK of this Section.
- C. **Pipe Material Group No. 15.** The piping system defined in this section is referred to in the Pipe Schedule on Contract Sheet G009 as Piping Material Group No. 15 (for schedule 10S pipe).

### PART 2 -- PRODUCTS

#### 2.1 PIPE MATERIAL

- A. Unless otherwise indicated, stainless steel pipe shall be in accordance with ASTM A 312 - Seamless and Welded Austenitic Stainless Steel Pipe, Type 316, seamless, Schedule 10S, with welded fittings or flanged fittings.

#### 2.2 PIPE JOINTS

- A. Stainless steel pipe shall have welded joints with socket-welding fittings, butt-welding fittings, or socket welding flanges. Stainless steel flanges shall have stainless steel bolts and nuts.

#### 2.3 FITTINGS

- A. **Socket-Welding Fittings:** Forged stainless steel fittings conforming to ASME B 16.11, Type 316.
- B. **Butt-Welding Fittings:** Wrought stainless steel butt-welding fittings conforming to ASTM A 403 - Wrought Austenitic Stainless Steel Piping Fittings, and ASME B 16.9 - Factory-Made Wrought Steel Butt-Welding Fittings, Type 316.
- C. **Flanged Fittings:** Type 316 stainless steel flanged fittings and flanges conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings.
- D. **Pressure Class:** Unless otherwise indicated, fittings shall be in accordance with the pressure classes called for in the Piping Schedule. Where not indicated, the fittings shall have the same pressure rating as the pipe.

### PART 3 -- EXECUTION

#### 3.1 INSTALLATION

- A. **General:** Stainless steel pipe shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be free from defects.
- B. **Valves and Unions:** Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends.

### 3.2 PIPE PREPARATION

- A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Fittings shall be equally cleaned before assembly.

### 3.3 PIPE JOINTS

- A. **Welded Joints:** Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders per Section 40 23 00 - Piping, General.
  - 1. Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the Site, providing the butt welds are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.
  - 2. Residue, oxide, and heat stain shall be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as **Eutectic Company's "Euclean"** or equal, followed by complete removal of the agent.

### 3.4 INSPECTION AND FIELD TESTING

- A. **Inspection:** The finished installation shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Defects shall be repaired.
- B. **Field Testing:** Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1.5 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements refer to Section 01 74 30 - Pressure Pipe Testing and Disinfection.
  - 1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to

the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

- END OF SECTION -



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## **SECTION 40 23 19 - DUCTILE IRON PIPE (AWWA C151, MODIFIED)**

### **PART 1 -- GENERAL**

#### **1.1 THE SUMMARY**

- A. The CONTRACTOR shall provide ductile iron pipe and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

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

- A. Commercial Standards

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water
AWWA C153	Ductile-Iron Compact Fittings for Water Service
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
ASTM C 150	Portland Cement

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Furnish Submittals in accordance with Section 01 33 00 - Contractor Submittals and the following supplemental requirements:
- B. Shop Drawings
  - 1. Certified dimensional drawings of valves, fittings, and appurtenances.
  - 2. Line layout and marking diagrams which indicate the specific number of each fitting and the location and the direction of each fitting in the completed line.

In addition, the line layouts shall include: the pipe station and invert elevation at changes in grade or horizontal alignment; elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained joints, or of concrete encasement.

- C. **Certifications:** Certified affidavit of compliance for pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:
  - 1. Physical and chemical properties.
  - 2. Hydrostatic test reports.
- D. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

#### 1.4 QUALITY CONTROL

- A. **Tests:** Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- B. The CONTRACTOR shall perform said material tests as part of the WORK. The ENGINEER shall have the right to witness testing conducted by the CONTRACTOR; provided, that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.
- C. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including lining and coating samples for testing by the OWNER. The additional samples shall be furnished as a part of the WORK.
- D. **Inspection:** Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 Days prior to the start of any phase of the pipe manufacture.
- E. During the manufacture of the pipe, the ENGINEER shall be given access to areas where manufacturing is in process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

## PART 2 -- PRODUCTS

### 2.1 PIPE GENERAL

- A. Mortar-lined and polyethylene-wrapped ductile iron pipe shall conform to AWWA C151, C104, and C105, subject to the supplemental requirements in this Section. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

- B. **Handling and Storage:** The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the coating will not be damaged. The pipe shall not be rolled and shall be secured to prevent accidental rolling
- C. **Laying Lengths:** Nominal pipe laying lengths shall be 20-ft.
- D. **Finish:** The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.
- E. **Closures and Correction Pieces:** Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the Drawings. The locations of correction pieces and closure assemblies are indicated. Any change in location or number of said items shall only be as accepted by the ENGINEER.

## 2.2 SPECIALS AND FITTINGS

- A. Fittings for ductile iron pipe shall conform to the requirements of AWWA C153 or AWWA C110 and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inches shall conform to AWWA C153.

## 2.3 DESIGN OF PIPE

- A. The pipe shall be designed, manufactured, tested, inspected, and marked according to AWWA C150 and C 151 except where modified by this Section.
- B. **Pipe Dimensions:** The pipe shall be of the diameter and class indicated.
- C. **Fitting Dimensions:** The fittings shall be of the diameter and class indicated.
- D. **Joint Design:** Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, or restrained joints as required.
  - 1. Mechanical and push-on joints shall conform to AWWA C111.
  - 2. Flanged joints shall conform to AWWA C115. Where threaded flanges are provided, the pipe wall thickness under the cut threads shall not be less than the calculated net thickness required for the pressure class of the pipe.
  - 3. Joint restraining devices that impart point loads and/or wedging action on the pipe wall as a means of joint restraint shall not be allowed unless there are no other options for joint restraint available. Under such circumstances, the CONTRACTOR may propose such devices provided the following conditions are met and the request is made as a substitution:

- a. A formal request for substitution is submitted stating the locations where the devices are intended to be used and a statement from the device manufacturer and the pipe manufacturer that the proposed device is appropriate for the intended installation and is rated at least for the class of the pipe being supplied.
  - b. A statement from the pipe manufacturer is provided accepting the use of the retaining devices and indicating that the use of such devices will in no way affect the warranty of the pipe and/or the performance of the pipe.
  - c. The manufacturer of the device and the pipe manufacturer jointly provide instruction on the proper installation of the device to the personnel installing the units and provide certification to the OWNER that the installers are adequately trained in the installation of the units and that warranties are in full affect for the project.
  - d. The devices shall be **MegaLug Model 1100** as manufactured by **EBAA Iron** or equal.
- E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

## 2.4 CEMENT-MORTAR LINING

- A. **Cement-Mortar Lining for Shop Application:** Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.
- 1. Cement: Cement for mortar lining shall conform to the requirements of AWWA C104; provided, that cement for mortar lining shall be Type II or V. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.
- B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter, in	Minimum Lining Thickness, in
3 - 12	1/16

14 - 24	3/32
30 - 64	1/8

## 2.5 EXTERIOR PROTECTION OF PIPE

- A. **Exterior Coating of Exposed Piping:** The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09 96 00 - Protective Coatings.
- B. **Exterior Coating of Buried Piping:** The exterior coating shall be an asphaltic coating approximately 1-mil thick.
- C. **Polyethylene Sleeve:** Sleeves shall conform to the requirements of AWWA C105, CONTRACTOR's choice between tubular 8-mil thick linear low-density film or 4-mil thick high-density cross-laminated film. Color shall be white.

## PART 3 -- EXECUTION

### 3.1 INSTALLATION OF PIPE

- A. The CONTRACTOR shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the CONTRACTOR.
- B. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of pipes and fittings in the trench shall be closed during any interruption to the WORK.
- C. **Pipe Laying:** The pipe shall be installed in accordance with AWWA C600.
- D. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- E. Each section of pipe 24-inches diameter and larger shall be laid in the order and position shown on the laying schedule. Each section shall be laid to the line and grade, within approximately one-inch plus or minus.
- F. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or

by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

- G. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.
- H. **Cold Weather Protection:** No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.
- I. **Pipe and Specials Protection:** The openings of pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.
- J. **Pipe Cleanup:** As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris. The CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying and shall perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.

### 3.2 RUBBER GASKETED JOINTS

- A. **Rubber Gasketed Joints:** Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket shall be placed in the bell groove. The spigot end of the pipe and the inside surface of the gasket shall be carefully cleaned and lubricated. The lubricant shall be suitable for lubricating the parts of the joint for assembly and be a compound listed as in compliance with NSF Standard 61. The lubricant shall be nontoxic, shall not support the growth of bacteria, and shall have no deleterious effects on the gasket material. The lubricant shall not impart taste or odor to water in the pipe. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

### 3.3 POLYETHYLENE SLEEVE UNBONDED PROTECTION

- A. Buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of AWWA C105, CONTRACTOR's choice between Method A or Method B.

### 3.4 INSTALLATION OF PIPE APPURTENANCES

- A. **Protection of Appurtenances:** Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind. Where pipe is encased in polyethylene sleeves, buried appurtenances shall be encased in polyethylene.

- B. **Installation of Valves:** Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The CONTRACTOR shall adjust stem packing and operate each valve prior to installation to insure proper operation.
- C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

### 3.5 FIELD TESTING

- A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1.5 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices.
- B. Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.
- C. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

- END OF SECTION -



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## SECTION 40 23 20 - HIGH DENSITY POLYETHYLENE (HDPE) PIPE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide high density polyethylene (HDPE) pipe, complete and in place, in accordance with this Scope of Work.
- B. **Pipe Material Group No. 31.** This piping system is referred to in the Pipe Schedule as Piping Material Group No. 31.

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

##### A. Commercial Standards

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by extrusion Plastometer
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D2239	Standard Specification for Polyethylene (PE) Plastic Pipe (S.I.D.R.-PR) Based on Controlled Inside Diameter
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D2737	Standard Specification for Polyethylene (PE) Plastic Tubing
ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D3035	Standard Specifications for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D3350	Standard Specification for Polyethylene Plastic Pipe and Fittings Material
ASTM F412	Standard Terminology Relating to Plastic Piping Systems
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (S.D.R.-PR) Based on Outside Diameter
ASTM F1473	Standard Test Method for Notch Tensile to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 63 in., For Water Distribution and Transmission
NSF Standard 014	Plastics Piping System Components and Related Materials
NSF Standard 061	Drinking Water System Components - Health Effects

### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Submit shop drawings and the manufacturer's descriptive literature and certifications on all equipment listed in this specification prior to the product installations and associated fabrications.

### 1.4 WARRANTY

- A. Materials and workmanship shall have a one-year warranty to be free from defects in workmanship and materials. The warranty will be from the date of completion of construction. If deficiencies are discovered during the warranty period, the CONTRACTOR shall be required to correct these deficiencies without additional charge to the OWNER.

## PART 2 -- PRODUCTS

### 2.1 PIPE MATERIAL

- A. The HDPE pipe shall be manufactured in a plant capable of providing continuous quality control through inspection. The facility shall have the necessary testing equipment to verify that the pipe meets the requirements of AWWA C901 or C906, NSF Standard #61 and ASTM standards.
- B. Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE 3608. The resin shall meet the requirements of ASTM D3350.
- C. Pipe shall have a manufacturing standard of ASTM F-714. All fish release piping shall be DR 26, unless noted otherwise.

- D. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.
- E. HDPE shall be flexible, non-toxic and black. The pipe shall have a minimum wall thickness corresponding to the DR designation as in this Section. Pipe shall be accordance with ASTM F714.
- F. The material shall be of virgin quality.
- G. Pipe diameters shown on the drawings shall be **the nominal diameter** of pipe, following the Iron Pipe Size (IPS) convention.
- H. High-density polyethylene pipe and fittings are to be supplied by one manufacturer and meet ASTM D3350.
- I. Fish Release HDPE pipe shall be flanged with a hole pattern to connect to the outlet structure. All surfaces of the pipe that a fish may come into contact with shall be ground smooth providing fish friendly surfaces. Pipe shall be provided in lengths as designated on the drawings. CONTRACTOR shall coordinate with OWNER for transport of the pipe to the OWNER's storage area upon completion of facility start up testing.
- J. On outfall pipes that transfer fish, at all joints to other pipe materials, the interior of the HDPE pipe shall be trimmed at no more than a 45-degree angle, to smoothly match the inside diameter of the other pipe material, with no sharp edges allowed.

## 2.2 FITTINGS

- A. Butt Fusion Fittings. HDPE fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02 and approved for AWWA use. Butt fusion fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the Quality Control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- B. The manufacturing facility shall have the necessary testing equipment to verify that the fittings meet the requirements of AWWA C901 for sizes ½" to 2" and AWWA C906 for sizes 3" through 54".
- C. Polyethylene pipe and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE 3608. The resin shall meet the requirements of ASTM D3350. High-density polyethylene pipe and fittings are to be supplied by one manufacturer.
- D. Fittings shall be the same material, thickness, and joint type as pipe to which it is connected and in accordance with ASTM D3261.

- E. All internal weld beads shall be smooth and shall protrude into the pipe no more than 1/8 inch

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION**

- A. All pipe shall be installed in strict accordance with manufacturer's recommendations, drawings and/or specifications and in the best commercial trade practice.
- B. Pipe and fittings shall be packaged in a manner suitable for shipment by a commercial carrier. Upon receipt at Work Site, a receiving inspection shall be prepared. The quantity shall be verified, and any shipping damage shall be reported to the supplier within 7 days.
- C. Trenches shall be excavated in accordance with the plans and specifications. OSHA standards or OWNER safety policies regarding safety shall be followed regarding trench safety. If groundwater is encountered, it shall be removed by the CONTRACTOR. Shoring of the trench, where required is the responsibility of the CONTRACTOR.
- D. Flanges/MJ adapters shall be attached to pipe and fittings using butt fusion. The flanges/MJ adapters shall be aligned and centered relative to the pipe. Flanges/MJ adapters should be square with the valve or other flange before tightening of bolts. Bolts should not be used to draw flanges into alignment. Bolt threads shall be lubricated, and flat washers shall be used under flange nuts. Bolts shall be tightened using a "star tightening pattern". See manufacturer's recommendations. Twenty-four hours after first tightening the flange bolts, they must be re-tightened using the same "star tightening pattern used above. The final tightening torque shall be as indicated by the manufacturer.
- E. Wherever a pipe passes from concrete to earth, a flanged connection, mechanical seal or a flexible joint shall be installed as shown or required. Particular care shall be taken to ensure a full support of the pipe in the earth between and beyond the joints. Pipe passing through concrete wall shall have integrally cast or welded on water stop ring cast into wall.
- F. Where pipes pass through walls and floors, extreme care shall be exercised to ensure joints are watertight. HDPE wall anchors with integral seep rings shall be used at all wall connections. The pipe shall be free of all dirt and grease to secure a tight bond with the concrete.
- G. Plain end pipe and fittings shall be made using butt fusion. The butt fusion procedures shall be in accordance with the manufacturer or the PPI. The fusion equipment operator shall receive training using the recommended procedure. The CONTRACTOR shall be responsible to verify that the fusion equipment is in good operating condition and that the operator has been trained within the past twelve months. The fusion equipment shall be equipped with a Datalogger. Records of the welds (heater temperature, fusion pressure, and a graph of the fusion cycle) shall be maintained for five (5) years and supplied to the OWNER upon request.

- H. For all fish release pipes, internal beads shall be removed using a de-beading machine (de-bader) for pipes up to 20 inches in diameter (internal). Above 20 inch diameter pipes internal beads shall be removed by entering the pipe and grinding smooth.
- I. Heat Fusion Training. The supplier of the pipe and fittings shall provide a person certified by the pipe manufacturer and the fusion equipment manufacturer to train CONTRACTOR fusion equipment operators and inspectors representing the OWNER.
- J. Mechanical Joining. Polyethylene pipe and fittings shall be joined together using Flanges or Mechanical Joint (MJ) adapters. These fittings shall be made from PE 3608 HDPE, with a Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and MJ adapters shall have a manufacturing standard of ASTM D3261. They shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

### 3.2 INSPECTION AND FIELD TESTING

- A. Inspection: Finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Defective Work shall be repaired.
- B. Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.
- C. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

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## SECTION 40 23 22 - PVC PRESSURE PIPE

### GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide polyvinyl chloride (PVC) pressure pipe, complete and in place, in accordance with the Contract Documents.
- B. **Pipe Material Group No. 16.** This piping system is referred to in the Pipe Schedule as Piping Material Group No. 16.
- C. The requirements of Section 40 23 00 - Piping, General, apply to the WORK of this Section.
- D. This Section includes PVC pressure pipe with solvent-welded, flanged, or screwed joints.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings:** The CONTRACTOR shall submit Shop Drawings of pipe, joints, bends, special fittings, and piping appurtenances.

### PART 2 -- PRODUCTS

#### 2.1 PIPE MATERIAL

- A. PVC pipe shall be made from new rigid unplasticized polyvinyl chloride and shall be normal impact Type 1, Grade 1, Class 12454, listed as compliant with NSF Standard 61, unless otherwise indicated, in accordance with ASTM D1785 – Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

#### 2.2 PIPE JOINTS

- A. Pipe joints shall be solvent-welded type with solvent cement and primer as recommended by the pipe manufacturer for the chemical in the pipe.
- B. Screwed joints that are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape.
- C. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ASME B16.5 – Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water service.

#### 2.3 FITTINGS

- A. **Solvent Welded and Threaded Fittings:** Solvent-welded and threaded fittings shall be compact type, Schedule to match pipe PVC fittings in accordance with ASTM D2466 or



ASTM D2467 – Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, to match pipe schedule.

- B. **Flanged Fittings:** Flanged fittings shall be Schedule to match fabricated PVC fittings with 150 lb. flanges to ASME B16.5.

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. **General:** PVC pipe shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary, piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. It is recommended that the CONTRACTOR obtain the assistance of the pipe manufacturer's field representative to instruct the pipefitters in the correct installation and support of PVC piping.
- B. **Supports and Anchors:** Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 23 02 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature changes.
- C. **Valves and Unions:** Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection. Valves and flanges attached to PVC pipe shall be provided with adequate supports.

### **3.2 PIPE PREPARATION**

- A. Prior to installation, each pipe length shall be carefully inspected, flushed clean of any debris or dust, and be straightened, if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

### **3.3 PIPE JOINTS**

- A. **Solvent-Welded Joints:** Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.
- B. **Flange Joints:** Flanged joints shall be made with gaskets and galvanized steel bolts and nuts. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

### 3.4 INSPECTION AND FIELD TESTING

- A. **Inspection:** Finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interferences, and damage to pipe, fittings, and coating. Defective WORK shall be repaired.
- B. **Field Testing:** The CONTRACTOR shall allow adequate time for the solvent cement joints to cure. Curing time shall be per the solvent cement manufacturer's recommendation. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Caution – Do not use air or gas for testing PVC pipe. Where no pressures are indicated, the pipes shall be subject to 1.5 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices.
- C. Leakage shall be determined by loss of pressure. Fixtures, devices, or other accessories that would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines shall be plugged or capped as appropriate during the testing procedures.
- D. Leaks shall be repaired, and the piping shall be re-tested until no leaks are found.

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## SECTION 40 90 00 - PROCESS INSTRUMENTATION AND CONTROL, GENERAL

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide a Supervisory Control and Data Acquisition (SCADA) system complete and operable, in accordance with the Contract Documents.
- B. The requirements of this section apply to every component of the SCADA system unless indicated otherwise.
- C. **Responsibilities:**
  - 1. The CONTRACTOR, through the use of an Instrumentation Supplier and qualified electrical and mechanical installers, shall be responsible for the implementation of the SCADA system and the integration of the SCADA system with other required instrumentation and control devices.
  - 2. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the Instrumentation Supplier be responsible to the CONTRACTOR for the integration of the SCADA system with devices provided under other sections with the objective of providing a completely integrated control system fully functional and free of signal incompatibilities.
  - 3. As a minimum, the Instrumentation Supplier shall perform the following WORK:
    - a. Implementation of the SCADA system:
      - 1) Prepare all hardware submittals.
      - 2) Design, develop, and electronically draft loop drawings and control panel designs.
      - 3) Prepare the test plan, the training plan, and the spare parts submittals.
      - 4) Procure hardware.
      - 5) Fabricate panels.
      - 6) Perform factory tests on panels.
      - 7) Perform bench calibration and verify calibration after installation.
      - 8) Oversee and certify installation.
      - 9) Oversee, document, and certify loop testing.
      - 10) Oversee, document, and certify system commissioning.
      - 11) Conduct the performance test.

- 12) Prepare Technical Manuals.
  - 13) Conduct training classes.
  - 14) Prepare record drawings.
- b. Integration of the SCADA system with instrumentation and control devices provided under other sections:
- 1) Develop requisite loop drawings and record loop drawings associated with equipment provided under other divisions of these specifications and OWNER-furnished equipment.
  - 2) Resolve signal, power, or functional incompatibilities between the SCADA system and interfacing devices.
4. Any Instrumentation Supplier responsibilities in addition to the list above are at the discretion of the CONTRACTOR and the Instrumentation Supplier. Additional requirements in this section and throughout Division 40 that are stated to be the CONTRACTOR'S responsibility may be performed by the Instrumentation Supplier if the CONTRACTOR and Instrumentation Supplier so agree.
- D. All process instrumentation is listed in the Instrumentation Schedule under Part 4 – Appendix A of Section 40 90 10 – Instrumentation for Process Systems.
- E. All process control data points (input/output points) (I/O points) are listed in the PLC I/O Schedule under Part 4 – Appendix A of this section.
- 1.2 RELATED SECTIONS
- A. Section 40 90 05 – Control Enclosures and Devices
  - B. Section 40 90 10 – Instrumentation for Process Systems
  - C. Section 40 90 18 – Vendor Package Control Systems
- 1.3 REFERENCE STANDARDS
- A. The following is a list of standards that may be referenced in this section:
- Instrument Society of America Standard (ISA)**
- |     |  |
|-----|--|
| 5.1 | Instrumentation Symbols and Identification   |
| 5.4 | Instrument Loop Drawings   |
| 20  | Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves |
- National Fire Protection Agency (NFPA)**
- |    |                          |
|----|--------------------------|
| 70 | National Electrical Code |
|----|--------------------------|

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Industrial Control Equipment

**1.4 CONTRACTOR SUBMITTALS**

**A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals and the following:**

1. The CONTRACTOR shall coordinate the instrumentation WORK so that the complete instrumentation and control system will be provided and will be supported by accurate shop drawings and record drawings.
2. Exchange of Technical Information: During the period of preparation of these submittals, the CONTRACTOR shall authorize a direct, informal liaison with the OWNER'S REPRESENTATIVE for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the OWNER'S REPRESENTATIVE, but will not alter the scope of WORK or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the OWNER'S REPRESENTATIVE shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.
3. Symbolology and Nomenclature: In these Contract Documents, systems, meters, instruments, and other elements are represented schematically, and are designated by symbolology as derived from ISA 5.1. The nomenclature and numbers designated herein and on the drawings shall be employed exclusively throughout shop drawings and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the drawings.

**B. Shop Drawings:**

**1. General:**

- a. Shop drawings shall include the letter head or title block of the Instrumentation Supplier. The title block shall include, at a minimum, the Instrumentation Supplier's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing. The quantity of submittal sets shall be as indicated in Section 01 33 00 - Contractor Submittals.
- b. Organization of the shop drawing submittals shall be compatible with eventual submittals for later inclusion in the Technical Manual. Submittals not so organized and incomplete submittals for a given loop will not be accepted.
- c. Shop drawing information shall be bound in standard size, 3-ring, loose-leaf, vinyl plastic, and hard cover binders suitable for bookshelf storage.

- d. Interfaces between instruments, motor starters, control valves, variable speed drives, flow meters, chemical feeders, and other equipment related to the SCADA system shall be included in the shop drawing submittal.
2. Hardware Equipment Submittal: The CONTRACTOR shall submit a complete bound package at one time within 60 days after the commencement date stated in the Notice to Proceed, including:
- a. A complete index which lists each device by tag number, type, and manufacturer. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover multiple identical uses of that instrument in that system. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.
  - b. Fully executed data sheets according to ISA 20 for each component, together with a technical product brochure or bulletin. The technical product brochures shall be complete enough to verify conformance to Contract Document requirements. The data sheets, as a minimum, shall show:
    - 1) Component functional description used in the Contract Documents.
    - 2) Manufacturer's model number or other product designation.
    - 3) Project tag number used in the Contract Documents.
    - 4) Project system or loop of which the component is a part.
    - 5) Project location or assembly at which the component is to be installed.
    - 6) Input and output characteristics.
    - 7) Scale, range, units, and multiplier (if any).
    - 8) Requirements for electric supply (if any).
    - 9) Requirements for air supply (if any).
    - 10) Materials of component parts to be in contact with or otherwise exposed to process media and corrosive ambient air.
    - 11) Special requirements or features.
  - c. Flowmeter Sizing Calculations: Calculations shall be submitted on the instrument manufacturer letterhead and shall include the following:
    - 1) Guaranteed meter accuracy based on the upstream and downstream straight runs associated with the location of each meter.

- 2) Permanent head loss associated with each meter.
  - 3) Flow vs. differential pressure curves for each head-type device. For compressible fluids, curves shall be pressure- and temperature-compensated.
  - 4) References to ASME standard equations used.
  - 5) Values used for every parameter used in calculations.
- d. Priced list of spare parts for every device.
- e. Instrument installation, mounting, and anchoring details shall be submitted in an electronic and hard copy format. Each instrument shall have a dedicated 8-1/2" by 11" detail that only pertains to the specific instrument by tag number. Each detail shall be certified by the instrument manufacturer that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable. These certifications shall be embedded in the CAD files and also appear as a stamp on the hard copies. As a minimum, each detail shall have the following contents:
- 1) Show necessary sections and elevation views required to define instrument location by referencing tank, building, or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor.
  - 2) Ambient temperature and humidity of the environment that the instrument is to be installed in.
  - 3) Corrosive qualities of the environment that the instrument is to be installed in.
  - 4) Hazardous rating of the environment that the instrument is to be installed in.
  - 5) Process line pipe or tank size, service, and material.
  - 6) Process tap elevation and location.
  - 7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
  - 8) Routing of tubing and identification of supports.
  - 9) Mounting brackets, stands, and anchoring devices.
  - 10) Conduit entry size, number, location, and delineation between power and signal.
  - 11) NEMA ratings of enclosures and components.
  - 12) Clearances required for instrument servicing.



- 13) List itemizing manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.
3. Project-Wide Loop Drawing Submittal: The CONTRACTOR shall furnish a Project-wide Loop Drawing Submittal (PLDS) which completely defines and documents the contents of each monitoring, alarming, interlock, and control loop associated with equipment provided under Division 40 sections, equipment provided under sections in other divisions, and OWNER-furnished equipment which is to be incorporated into the SCADA system. The PLDS shall be a singular complete bound package electronically drafted, submitted within 120 days after contract award, and shall include the following:
    - a. A complete index in the front of each bound volume. The loop drawings shall be indexed by systems or process areas. Loops shall be tagged in a manner consistent with the Contract Documents. Loop drawings shall be submitted for every analog and discrete monitoring and control loop.
    - b. Drawings showing definitive diagrams for every analog and discrete instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ISA 5.4 and as defined by the most recent revision in ISA. Loop drawings shall be developed for loops in equipment vendor-supplied packages, equipment provided under Division 40, and OWNER-furnished equipment. In addition to the expanded ISA 5.4 requirements, the loop diagrams shall also show the following details:
      - 1) Functional name of each loop.
      - 2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
      - 3) Panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.
      - 4) Designation, and if appropriate, terminal assignments associated with every manhole, pullbox, junction box, conduit, and panel through which the loop circuits pass.
      - 5) Vendor panel, instrument panel, conduit, junction boxes, equipment and SCADA terminations, termination identification wire numbers and colors, power circuits, and ground identifications.
    - c. Itemized Instrument Summary: The summary shall be prepared with software and shall be submitted on electronic media and hard copy. The instrument summary shall list all the key attributes of each instrument provided under this contract. As a minimum, attributes shall include:
      - 1) Tag number.
      - 2) Manufacturer.

- 3) Model number.
  - 4) Service.
  - 5) Area location.
  - 6) Calibrated range.
  - 7) Loop drawing number.
  - 8) Associated LCP, PLC, PCM, or RTU.
4. Startup Submittals:
- a. The CONTRACTOR shall submit the proposed procedures to be followed during startup of the SCADA system and its components.
  - b. Detailed Submittal: The CONTRACTOR shall submit the proposed detailed procedures, forms, and checklists. This submittal shall include a statement of objectives with the test procedures.
5. Training Submittals: The CONTRACTOR shall submit a training plan which includes:
- a. Training plan overview.
  - b. Schedule of training courses including dates, durations, and locations of each class.
  - c. Resumes of the instructors who will actually implement the plan.

C. Technical Manual:

1. General: Information in the Technical Manual shall be based upon the approved shop drawing submittals as modified for conditions encountered in the field during the WORK.
2. The Technical Manual shall have the following organization for each process:
  - a. Section A - Process and Instrumentation Diagrams.
  - b. Section B - Loop Descriptions.
  - c. Section C - Loop Drawings.
  - d. Section D - Instrument Summary.
  - e. Section E - Instrument Data Sheets.
  - f. Section F - Sizing Calculations.
  - g. Section G - Instrument Installation Details.

- h. Section H - Test Results.
  - 3. Signed results from Loop Testing, Pre-Commissioning, and Performance Testing shall be included in Section H.
  - 4. Initially, two sets of draft Technical Manuals shall be submitted for review after return of favorably reviewed shop drawings and data required herein. Following the OWNER'S REPRESENTATIVE's review, one set will be returned to the CONTRACTOR with comments. The Manuals shall be revised and amended as required and the final Manuals shall be submitted 15 days prior to startup of systems.
- D. Record Drawings:
- 1. The CONTRACTOR shall keep current a set of complete loop and schematic diagrams which shall include field and panel wiring, routing, mounting details, point-to-point diagrams with cable, wire, and termination numbers. These drawings shall include every instrument and instrument element. One set of drawings electronically formatted and two hard copies shall be submitted after completion of Pre-Commissioning tasks but prior to Performance Testing. Such drawings shall be submitted for review prior to acceptance of the completed WORK by the OWNER.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. **Code and Regulatory Compliance:** SCADA system WORK shall conform to or exceed the applicable requirements of the NEC. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.
- B. **Current Technology:** Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings, unless otherwise required to match existing equipment.
- C. **Hardware Commonality:** Instruments which utilize a common measurement principle (e.g. d/p cells, pressure transmitters, level transmitters that monitor hydrostatic head, etc.) shall be furnished by a single manufacturer. Panel-mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.
- D. **Loop Accuracy:** The accuracy of each instrumentation system or loop shall be determined as a probable maximum error; this shall be the square root of the sum of the squares of certified "accuracies" of the designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual instrument shall have a minimum accuracy of plus and minus 0.5 percent of full scale and a minimum repeatability of plus and minus 0.25 percent of full scale, unless otherwise indicated. Instruments that do not conform to or improve upon these criteria are not acceptable.
- E. **Instrument and Loop Power:** Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in

and be supplied by the control panel devices. Use 2-wire transmitters over 4-wire transmitters wherever possible. Individual loop or redundant power supplies shall be provided as required by the manufacturer's instrument load characteristics to ensure sufficient power to each loop component. Power supplies shall be mounted within control panels or in the field at the point of application.

- F. **Loop Isolators and Converters:** Signal isolators shall be provided as required to ensure adjacent component impedance match where feedback paths may be generated, or to maintain loop integrity during the removal of a loop component. Dropping precision wirewound resistors shall be installed at field side terminations in the control panels to ensure loop integrity. Signal conditioners and converters shall be provided where required to resolve any signal level incompatibilities or provide required functions.
- G. **Environmental Suitability:** Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The CONTRACTOR shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.
- H. **Signal Levels:** Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals shall be 4 to 20 milliamperes dc, except as indicated. Electrical signals shall be electrically or optically isolated from other signals.
- I. **Control Panel Power Supplies:** Control panels shall be provided with redundant power supplies which are configured in a fault-tolerant manner to prevent interruption of service upon failure and interruption of service necessitated by the replacement of a power supply. Power supplies shall have an excess rated capacity of 40 percent. The failure of a power supply shall be annunciated at the control panel and repeated to the SCADA System.
- J. **Alternative Equipment and Methods:** Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the OWNER'S REPRESENTATIVE through the "or equal" process of the bid forms. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage, and maintenance enhancement over the equipment or method indicated, or shall include evidence that an indicated component is not available.

## 2.2 OPERATING CONDITIONS

- A. The SCADA system shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:

Environment	Indoors, in a dry, cooled environment
Temperature Range	50 through 104 degrees F

Thermal Shock	1 degree F per minute, max
Relative Humidity	20 through 90 percent, non-condensing

## 2.3 CONTROL SYSTEM PRODUCTS

- A. All control system enclosures, components, and devices, including but not limited to PLCs, HMIs, power supplies, control relays, pilot devices, and network switches shall be provided in accordance with Section 40 90 05 – Control Enclosures and Devices.

## 2.4 SPARE PARTS AND SPECIAL TOOLS

- A. The CONTRACTOR shall furnish a priced list of special tools required to calibrate and maintain the instrumentation provided. After approval, the CONTRACTOR shall furnish tools on that list.
- B. Special tools and spare parts shall be submitted before startup commences, suitably wrapped and identified.

## 2.5 FACTORY TESTING

- A. The CONTRACTOR shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this section to allow the OWNER'S REPRESENTATIVE and OWNER to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the OWNER'S REPRESENTATIVE prior to testing. No shipments shall be made without the OWNER'S REPRESENTATIVE's approval.

# PART 3 -- EXECUTION

## 3.1 PRODUCT HANDLING

- A. **Shipping Precautions:** After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the site.
- B. **Special Instructions:** Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.
- C. **Tagging:** Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number,

as given in the tabulation, shall be provided on each piece of equipment in the SCADA system. Identification shall be prominently displayed on the outside of the package.

- D. **Storage:** Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the OWNER'S REPRESENTATIVE. If such tests reveal defects, the equipment shall be replaced.

### 3.2 MANUFACTURER'S SERVICES

- A. The CONTRACTOR shall furnish the following manufacturer's services for the instrumentation listed below:

1. Perform bench calibration.
2. Oversee installation.
3. Verify installation of installed instrument.
4. Certify installation and reconfirm manufacturer's accuracy statement.
5. Oversee loop testing, prepare loop validation sheets, and certify loop testing.
6. Prepare pre-commissioning validation sheets, oversee pre-commissioning, and certify when pre-commissioning is completed.
7. Train the OWNER'S personnel.

- B. Manufacturer's services shall be furnished for the following equipment:

1. Magnetic flowmeters 12" and larger.
2. Vendor Control Panels with associated instrumentation and signals as specified in Section 40 90 18 – Vendor Package Control Systems.

### 3.3 INSTALLATION

- A. **General:**

1. Instrumentation, including instrumentation furnished under other divisions, shall be installed under Division 40 and in accordance with the manufacturers' instructions.
2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the OWNER exercises the right to require

changes in location of equipment which do not impact material quantities or cause material rework, the CONTRACTOR shall make such changes without additional cost to the OWNER.

**B. Conduit, Cables, and Field Wiring:**

1. Conduit shall be provided under Division 26.
2. Process equipment control wiring, 4-20 mA signal circuits, signal wiring to field instruments, PLC input and output wiring, and other field wiring and cables shall be provided under Division 26.
3. PLC equipment cables shall be provided under Division 40.
4. Terminations and wire identification at SCADA system equipment furnished under this or any other division shall be provided under Division 40.

**C. Instrumentation Tie-Downs:** Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the site.

**D. Ancillary Devices:** The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The CONTRACTOR shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the OWNER'S REPRESENTATIVE for approval prior to commencing that WORK. Such changes shall not be a basis of claims for extra WORK or delay.

**E. Installation Criteria and Validation:** Field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Contract Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the approved shop drawings and data.
4. Flexible cables shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
5. Power and signal wires shall be terminated with crimped type lugs.
6. Connectors shall be watertight at a minimum.
7. Wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
8. Wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically

approved by the OWNER'S REPRESENTATIVE. Wiring shall be protected from sharp edges and corners.

9. Mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
10. Verify the correctness of each installation, including polarity of power and signal connections, and make sure process connections are free of leaks. The CONTRACTOR shall certify in writing that discrepancies have been corrected for each loop or system checked out.
11. The OWNER will not be responsible for any additional cost of rework attributable to actions of the CONTRACTOR or the Instrumentation Supplier.

### 3.4 CALIBRATION

- A. **General:** Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. **Calibration Points:** Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.
- C. **Bench Calibration:** Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the OWNER'S REPRESENTATIVE.
- D. **Field Calibration:** Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.
- E. **Calibration Sheets:** Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:
  1. Project name.
  2. Loop number.
  3. Tag number.
  4. Manufacturer.
  5. Model number.
  6. Serial number.
  7. Calibration range.



8. Calibration data: Input, output, and error at 0 percent, 50 percent, and 100 percent of span.
9. Switch setting, contact action, and deadband for discrete elements.
10. Space for comments.
11. Space for sign-off by Instrumentation Supplier and date.
12. Test equipment used and associated serial numbers.

- F. **Calibration Tags:** A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the OWNER'S REPRESENTATIVE. The CONTRACTOR shall have the Instrumentation Supplier sign the tag when calibration is complete. The OWNER'S REPRESENTATIVE will sign the tag when the calibration and testing has been accepted.

### 3.5 LOOP TESTING

- A. **General:** Individual instrument loop diagrams per ISA 5.4, expanded format, shall be submitted to the OWNER'S REPRESENTATIVE for review prior to the loop tests. The CONTRACTOR shall notify the OWNER'S REPRESENTATIVE of scheduled tests a minimum of 30 days prior to the estimated completion date of installation and wiring of the SCADA system. After the OWNER'S REPRESENTATIVE's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the OWNER'S REPRESENTATIVE.
- B. **Control Valve Tests:** Control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.
- C. **Interlocks:** Hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers, and packaged equipment controls shall be checked to the maximum extent possible.
- D. **Instrument and Instrument Component Validation:** Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirement, or, in the absence of a contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the OWNER'S REPRESENTATIVE.
- E. **Loop Validation:**
1. Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. Control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements,

final control elements, and the graphic displays associated with the PLC. Actual signals shall be used wherever available.

2. Following any necessary corrections, the loops shall be retested. Accuracy tolerances for each analog network are defined as the root-mean-square (RMS) summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contract requirements or by published manufacturer accuracy specifications, whenever contract accuracy requirements are not indicated.
  3. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks which incorporate analog elements, simulated sensor inputs corresponding to 0, 25, 50, 75, and 100 percent of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated RMS summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests.
  4. Analog loop test data shall be recorded on test forms attached at the end of this section which include calculated RMS summation system accuracy tolerance requirements for each output.
- F. **Loop Validation Sheets:** The CONTRACTOR shall prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the Instrumentation Supplier:
1. Project name.
  2. Loop number.
  3. Tag number, description, manufacturer, and model number for each element.
  4. Installation bulletin number.
  5. Specification sheet number.
  6. Loop description number.
  7. Adjustment check.
  8. Space for comments.
  9. Space for loop sign-off by Instrumentation Supplier and date.
  10. Space for OWNER'S REPRESENTATIVE witness signature and date.

- G. **Loop Certifications:** When installation tests have been successfully completed for individual instruments and separate analog control networks, a certified copy of each test form signed by the ENGINEER OF RECORD or the ENGINEER OF RECORD's representative as a witness, with test data entered, shall be submitted to the ENGINEER OF RECORD together with a clear and unequivocal statement that the instrumentation has been successfully calibrated, inspected, and tested.

### 3.6 PRE-COMMISSIONING

- A. **General:** Pre-Commissioning shall commence after acceptance of wire test, calibration tests and loop tests as specified in the Calibration and Loop Testing paragraphs above, and after inspections have demonstrated that the instrumentation and control system complies with contract requirements. Pre-Commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- B. **Pre-Commissioning Procedures and Documentation:** Pre-Commissioning and test activities shall follow detailed test procedures and check lists accepted by the OWNER'S REPRESENTATIVE. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the OWNER'S REPRESENTATIVE, which include calculated tolerance limits for each step. Completion of system pre-commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the OWNER'S REPRESENTATIVE with a clear and unequivocal statement that system pre-commissioning and test requirements have been satisfied.
- C. **Operational Validation:** Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor controls and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.
- D. **Loop Tuning:** Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

E. **Pre-Commissioning Validation Sheets:** Pre-commissioning shall be documented on one of two types of test forms as follows:

1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:
  - a. Project name.
  - b. Loop number.
  - c. Loop description.
  - d. Tag number, description, manufacturer, and data sheet number for each component.
  - e. Space for sign-off and date by both the Instrumentation Supplier and OWNER'S REPRESENTATIVE.
2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
  - a. Specification page and paragraph of function demonstrated.
  - b. Description of function.
  - c. Space for sign-off and date by both the Instrumentation Supplier and OWNER'S REPRESENTATIVE.

F. **Pre-Commissioning Certification:** The CONTRACTOR shall submit an instrumentation and control system pre-commissioning completion report which shall state that contract requirements have been met and shall include a listing of instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the OWNER'S REPRESENTATIVE before the performance testing may begin. Final acceptance of the control system shall be based upon project completion as stated in the General Conditions.

### 3.7 COMMISSIONING

- A. **General:** Commissioning shall commence after acceptance of the instrumentation and control system pre-commissioning completion report as specified in the Pre-Commissioning paragraph above.
- B. The entire WORK shall operate for 22 days longer than the commissioning period in Section 01 75 00 – Startup without failure.
- C. In addition to the commissioning requirements of Section 01 75 00 – Startup, the CONTRACTOR shall furnish support staff as required to operate the system and to satisfy the repair or replacement requirements.

- D. If any control component fails during the performance test, or if any error in logic occurs, it shall be repaired, replaced, or otherwise adjudicated, and the performance test shall be restarted at time zero on another 30-day period.
- E. If any unforeseen condition occurs during the performance test, the test shall be paused and the condition shall be evaluated within 24 hours. If the condition is determined to satisfy the three conditions listed for malfunction evaluation in Section 01 75 00 – Startup, then the test shall be permitted to resume at the elapsed time at which it was paused. If the condition does not satisfy all three of the above conditions, the unforeseen condition shall be repaired, replaced, or otherwise adjudicated, and the performance test shall be restarted at time zero on another 30-day period.

### 3.8 TRAINING

- A. **General:** The CONTRACTOR shall train the OWNER'S personnel on the maintenance, calibration, and repair of instruments provided under this contract.
- B. **Instructions:** The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.
- C. **Duration:** Each training class shall be a minimum of 8 hours in duration and shall cover, as a minimum, operational theory, maintenance, troubleshooting/repair, and calibration of the instrument.
- D. **Schedule:** Training shall be performed during the pre-commissioning phase of the project. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The OWNER'S REPRESENTATIVE will review the course outline for suitability and provide comments that shall be incorporated.
- E. **Agenda:** The training shall include operation and maintenance procedures, troubleshooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment.
- F. **Documentation:** Within 10 days after the completion of each session the CONTRACTOR shall submit the following:
  - 1. A list of OWNER personnel who attended the session.
  - 2. An evaluation of OWNER personnel via written testing or equivalent evaluation.
  - 3. A copy of the training materials utilized during the lesson with notes, diagrams, and comments.

### 3.9 CRITERIA FOR SUBSTANTIAL COMPLETION

- A. For the purpose of this section and all Division 40, the following conditions shall be fulfilled before the WORK is considered substantially complete:
  - 1. Submittals have been completed and approved.
  - 2. The SCADA system has been calibrated, loop tested, and pre-commissioned.

3. The OWNER training has been performed.
4. Spare parts and expendable supplies and test equipment have been delivered to the OWNER.
5. Commissioning has been successfully completed.
6. Punch-list items have been corrected.
7. Record drawings in both hard copy and electronic format have been submitted.
8. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.
9. Debris associated with installation of instrumentation has been removed.
10. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

#### **PART 4 -- APPENDIX**

- A. **PLC I/O Schedule:** The following PLC I/O Schedule is a compilation of all process data points included in the WORK related specifically to the SCADA cabinet PLC (PLC-090). Process data points for the traveling screen PLC or microcontroller shall be as shown on the Drawings and as specified under Section 35 79 13 – Traveling Belt Intake Screen.

<b>PLC I/O Schedule</b>					
<b>Discrete Inputs</b>					
<b>I/O Designation</b>	<b>Description</b>	<b>PLC-090 Slot</b>	<b>Channel</b>	<b>Range</b>	<b>Type</b>
YA-200	Traveling Screen Fault	01	DI-0	On/Off	N.O. Contact
HH-280	Meter Vault Flood Alarm	01	DI-1	On/Off	N.O. Contact
LO-300	Coho Incubation Tank Low Level	01	DI-2	On/Off	N.C. Contact
LO-500	Chinook Incubation Tank A Low Level	01	DI-3	On/Off	N.C. Contact
LO-501	Chinook Incubation Tank B Low Level	01	DI-4	On/Off	N.C. Contact
LO-502	Chinook Incubation Tank C Low Level	01	DI-5	On/Off	N.C. Contact
LO-503	Chinook Incubation Tank D Low Level	01	DI-6	On/Off	N.C. Contact
EL-090	UPS Battery On	01	DI-7	On/Off	N.O. Contact
TR-090	UPS Low Battery	01	DI-8	On/Off	N.O. Contact
YA-090	UPS Unit Fault	01	DI-9	On/Off	N.O. Contact
YA-091	Surge Protection Fault	01	DI-10	On/Off	N.C. Contact
YA-092	Ethernet Switch Fault	01	DI-11	On/Off	N.O. Contact
SU-090	Loss of DC Power	01	DI-12	On/Off	N.C. Contact
	Spare	01	DI-13		
	Spare	01	DI-14		

	Spare	01	DI-15		
YA-290	Meter Vault Intrusion Alarm	02	DI-0	On/Off	N.C. Loop
YA-390	Coho Building Intrusion Alarm	02	DI-1	On/Off	N.C. Loop
YA-590	Chinook Building Intrusion Alarm	02	DI-2	On/Off	N.C. Loop
YA-591	Electrical Room Intrusion Alarm	02	DI-3	On/Off	N.C. Loop
YA-690	Spawning Building Intrusion Alarm	02	DI-4	On/Off	N.C. Loop
YA-660	Waste Drain Wet Well Pump 1 Fault	02	DI-5	On/Off	N.O. Contact
YA-661	Waste Drain Wet Well Pump 2 Fault	02	DI-6	On/Off	N.O. Contact
HH-662	Waste Drain Wet Well High Level Alarm	02	DI-7	On/Off	N.O. Contact
	Spare	02	DI-8		
	Spare	02	DI-9		
	Spare	02	DI-10		
	Spare	02	DI-11		
	Spare	02	DI-12		
	Spare	02	DI-13		
	Spare	02	DI-14		
EN-090	Silence Siren Pushbutton	02	DI-15	On/Off	N.O. Contact
<b>Discrete Outputs</b>					
YA-093	General System Fault	03	DO-0	On/Off	Digital Out
YA-094	Intrusion Alarm	03	DO-1	On/Off	Digital Out
EN-091	Annunciate Siren	03	DO-2	On/Off	Digital Out
LO-010	Incubation Tanks Low Water	03	DO-3	On/Off	Digital Out
	Spare	03	DO-4		
	Spare	03	DO-5		
	Spare	03	DO-6		
	Spare	03	DO-7		
<b>Analog Inputs</b>					
FL-200	Coho Building RW Supply Flow	04	AI-0	0 – 1,000 gpm	Analog, 4-20 mA
FL-201	Adult Holding Ponds RW Supply Flow	04	AI-1	0 – 4,500 gpm	Analog, 4-20 mA
FL-202	Chinook Raceways RW Supply Flow	04	AI-2	0 – 4,500 gpm	Analog, 4-20 mA
FL-203	Chinook Building RW Supply Flow	04	AI-3	0 – 750 gpm	Analog, 4-20 mA
LV-200	Fall Creek Head Level at Intake Structure	05	AI-0	0 – 5 ft W.C.	Analog, 4-20 mA
LV-201	Water Level Behind Traveling Screen	05	AI-1	0 – 5 ft W.C.	Analog, 4-20 mA

	Spare	05	AI-2		Analog, 4-20 mA
	Spare	05	AI-3		Analog, 4-20 mA

- END OF SECTION -



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## SECTION 40 90 05 - CONTROL ENCLOSURES AND DEVICES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide control enclosures, control panels, control devices, and other control equipment for the WORK in accordance with this specification and the Contract Documents.
- B. The provisions of this section apply to all control enclosures, devices, and other related equipment of the WORK, except as indicated otherwise.
- C. Interconnecting wiring, raceway, and mounting hardware external to control panels shall be in accordance with the requirements of Division 26.
- D. In general, the provisions of Division 26 apply to materials furnished under this section. Where the requirements of this section conflict with Division 26 requirements, only the requirements of this section shall apply.

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **National Electrical Manufacturers Association (NEMA)**

250	Enclosure for Electrical Equipment (1000 Volts Maximum)
AB 1	Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
ICS 1	Industrial Control and Systems: General Requirements
ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
ICS 5	Control Circuit and Pilot Devices

##### **National Fire Protection Association (NFPA)**

70	National Electrical Code (NEC)
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##### **Underwriters Laboratories, Inc. (UL)**

44	Thermoset-Insulated Wires and Cables
83	Thermoplastic-Insulated Wires and Cables
486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
486F	Bare and Covered Ferrules
489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

508	Standard for Industrial Control Equipment
508A	Standard for Industrial Control Panels
1059	Standard for Terminal Blocks
1063	Standard for Machine-Tool Wires and Cables

### 1.3 SIGNAGE AND MARKINGS

- A. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal and state OSHA and NEC requirements.

### 1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals and individual equipment specification sections.
- B. All panel drawings shall, as a minimum, be 11 inches by 17 inches and data sheets and manufacturer specification sheets shall be 8-1/2 inches by 11 inches.
- C. **General Submittal Requirements:** Provide the following:
  - 1. Bill of material, with enumerated make and model of all devices used in construction of each control panel.
  - 2. Catalog cuts of bulletins or brochures for applicable standard equipment.
  - 3. Front, side, and backpanel elevations with dimensional data of each control panel, with matching enumeration to devices in bill of materials.
  - 4. Schematic and elementary diagrams.
  - 5. Interconnection diagrams that identify external connections between the control panel/control panel devices and associated equipment.
  - 6. Method of anchoring, seismic requirements, weight.
  - 7. Types of materials and finish.
  - 8. Nameplates.
  - 9. Voltage, phase, and current requirements.

### 1.5 SERVICE CONDITIONS

- A. **Ambient Temperature Range:**
  - 1. 50°F to 90°F for indoor equipment.
  - 2. 15°F to 100°F for outdoor equipment.
- B. **Site Elevation:** 2,500 feet above sea level.

## 1.6 QUALITY ASSURANCE

- A. Control panels shall be fabricated and wired in accordance with UL 508A and shall bear the UL label.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a singular manufacturer.
- B. Internal control components shall be mounted on an internal backpanel.
- C. Each separate source of externally derived voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front.
- D. Each control panel shall be provided with identified terminal strips for the connection of external conductors.
- E. Each motor starter shall be provided with relay dry-contacts for motor overload, local indication, and remote alarm, and as shown on Contract Drawings.
- F. Discrete outputs from the control panel shall be provided by dry contacts rated for 5 amps at 120 VAC. Analog inputs and outputs shall be isolated 4 to 20 mA, two-wire signals with power supply, unless noted otherwise.
- G. Control panel mounted devices shall be mounted a minimum of 3 feet above finished floor elevation.

### 2.2 CONTROL PANEL ENCLOSURE

- A. Enclosure shall be UL listed.
- B. Material shall be steel with 12-gauge minimum thickness.
- C. **Rating:** Enclosures shall be in accordance with NEMA 250 ratings and suitable for the environment in which they are installed:
  - 1. Indoor enclosures in dry areas shall be NEMA 1.
  - 2. Indoor enclosures in wet areas shall be NEMA 4 or better where spraying or splashing water may be present intermittently. Otherwise, enclosures shall be NEMA 3R or better.
  - 3. Outdoor enclosures shall be NEMA 3R or better.
  - 4. For areas not mentioned above, enclosures shall be NEMA 12 or better.
- D. All mounting hardware shall be stainless steel.

- E. Seams shall be continuously welded and ground smooth, with no holes or knockouts.
- F. Provide internal mounting channels welded horizontally to sides at top, bottom, and center of enclosure.
- G. Provide heavy duty lifting eyes.
- H. **Finish:** Exterior finish shall be white or stainless, as required. Interior finish shall be white.
- I. **Backpanel:**
  - 1. Installed inside enclosure at the rear for mounting control components.
  - 2. Painted steel with 14-gauge minimum thickness.
  - 3. Sized for the enclosure provided.
  - 4. Same finish as enclosure interior.
- J. **Doors:**
  - 1. Gasketed door with concealed, easy-to-remove hinges.
  - 2. Equipped with key-locking handle and three-point latch mechanism.
  - 3. Ground bonding provision on door.
  - 4. Data pocket inside door with handle, constructed of high-impact thermoplastic.
- K. **Device Mounting:**
  - 1. Provide door cutouts and mount pilot devices indicated to be door-mounted.
  - 2. Mount other accessory items behind the doors as required for complete functionality.
  - 3. Mounting devices to door shall not invalidate NEMA 250 enclosure rating. Furnish gaskets and other provisions to meet rating required.
- L. **Nameplates:**
  - 1. Provide control panel nameplate in accordance with Section 26 00 00 – Basic Electrical Requirements.
  - 2. Provide pilot device nameplates in accordance with Paragraph Pilot Devices herein, with inscriptions shown on drawings.
- M. **Environmental Suitability:** Control panel enclosure shall be suitable for operation in the ambient conditions associated with the locations designated in the drawings. Heating, cooling, and dehumidifying devices shall be provided in order to maintain instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges.

N. **Heat Dissipation:**

1. Provide vents, fans, and cooling equipment on freestanding panels to suitably dissipate heat generated by equipment mounted in or on the panel.
2. Installed vents, fans, and cooling equipment shall not invalidate NEMA 250 enclosure rating. Furnish gaskets, hoods, screens, and other provisions to meet rating required.

2.3 CONTROL PANEL ELECTRICAL

- A. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. Wiring shall be identified with thermally-imprinted heat-shrink wire end markers.
- B. **Wiring Methods:** Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring), unless otherwise indicated.
- C. Power supply to control panel shall be as indicated on the drawings.
- D. Control voltage shall be 24 Vdc and supplied by DIN-rail mounted power supply local to each control panel.
- E. Unless otherwise indicated, instruments, alarm systems, and control relays shall operate on 24 Vdc circuits.
- F. The control panel shall provide the source of power for any dry contacts external to the control panel that interconnect with the control panel.
- G. Interconnection wiring shall be allowed to enter from below and above control panel for indoor panels and from below only for outdoor panels.
- H. Bundle wiring neatly in wireways alongside control components.
- I. Label each terminal for permanent identification of leads.
- J. Wire and terminal identification shall be incorporated into the as-built drawings.
- K. For case grounding, panel shall be provided with a 1/4-inch by 1-inch copper ground bus complete with solderless connector for one no. 4 AWG bare stranded copper cable.

L. **Main Circuit Breaker:**

1. Meet requirements of NEMA AB 1 and UL 489.
2. Voltage: 480, 208, or 120 volts ac, with number of poles as required.
3. Interrupting Capacity: Same rating as upstream feeder breaker. Coordinate with Division 26 to determine final ratings.
4. Molded case inverse-time thermal-magnetic circuit breaker, with trip setting sized to protect motor and branch circuit conductors in accordance with NFPA 70 (National Electrical Code).

5. Individual thermal-magnetic trip elements in each pole.
6. Mechanism opens all poles when overcurrent occurs on any single pole.
7. Test button on cover.
8. Using single-pole circuit breakers with handle ties to make multi-pole circuit breakers will not be acceptable.
9. Capable of line side conductors landing at either end.
10. Mechanical lugs, except crimp compression lugs where shown.
11. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
12. Disconnecting Means:
  - a. Doors shall be mechanically interlocked with main circuit breaker by means of a defeatable rotary switch mounted on the door connected to an operating mechanism on the circuit breaker.
  - b. Disconnect shall be padlockable when de-energized with up to three locks.
  - c. Disconnect shall indicate ON, OFF, and TRIP states of main circuit breaker and shall allow reset of breaker without opening the cabinet.

**M. Combination Magnetic Starter:**

1. Horsepower rated at utilization voltage for size of motor being powered from the control panel; motor size as shown on Drawings.
2. Short Circuit Capacity:
  - a. Same rating as upstream panelboard bus or better. Coordinate with Division 26 to determine final ratings.
  - b. Starter shall be UL labeled for short circuit capacity at control panel voltage with overload protection.
3. Three-phase, full voltage type.
4. Reversing or non-reversing as required.
5. Assembly consisting of motor circuit protector, one or more motor contactors, and overload relay.
6. Contactors shall be mechanically interlocked to prevent simultaneous operation.
7. Starter shall be no smaller than NEMA ICS, Size 1.
8. Coil Voltage: 24 Vdc.

9. Control: As shown on drawings.
10. Auxiliary Contacts: Rated 5A at 120 Vac and 24 Vdc, quantity as shown on drawings.
11. Panel-mounted inside control panel.
12. Molded case motor circuit protector, with trip setting sized to protect motor and branch circuit conductors in accordance with NFPA 70 (National Electrical Code).
  - a. Individual magnetic trip elements in each pole.
  - b. Mechanism opens all poles when overcurrent occurs on any single pole.
  - c. Test button on cover.
  - d. Using single-pole circuit breakers with handle ties to make multi-pole circuit breakers will not be acceptable.
  - e. Capable of line side conductors landing at either end.
  - f. Mechanical lugs, except crimp compression lugs where shown.
  - g. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
13. Motor Overload Protection Relay:
  - a. Solid state, current operated circuitry with adjustable trip.
  - b. Inverse-time characteristic, Class 10/20/30 selectable relay trip.
  - c. Phase loss, phase unbalance, and ground fault protection.
  - d. Normally open (N.O.) and normally closed (N.C.) auxiliary contacts for remote indication.
  - e. Visual trip indication.
14. Manufacturers, or Equals:
  - a. Square D.
  - b. Eaton.

**N. Control Relays:**

1. Relays shall be plug-in type with indicator LED, manual latching-closed mechanism, rectangular blades, and provided with sockets for screw-type termination and hold-down clips.
2. DIN- or panel-mount, as required.



3. Coil Voltage: 24 Vdc, unless noted otherwise.
4. Contacts shall be dry and rated for 5A at 120 Vac and 24 Vdc.
5. Form C primary contacts (one normally open and one normally closed).
6. Number and configuration of auxiliary contacts as indicated in control diagrams on drawings, or as required for a complete and operable system, whichever is greater.
7. Time delay relays:
  - a. Solid state, combination ON delay and OFF delay (field-selectable), with adjustable range from 1 to 60 seconds, unless otherwise indicated.
  - b. Provide socket with screw-type termination and retaining strap.
  - c. Form C primary contacts (one normally open and one normally closed).
  - d. Number and configuration of auxiliary contacts as indicated in control diagrams on drawings or as required for a complete and operable system, whichever is greater.
8. Manufacturer, or Equal:
  - a. Phoenix Contact.
  - b. Eaton.
  - c. Square D.
  - d. General Electric.

**O. Pilot Devices:**

1. Devices shall be manufactured in accordance with NEMA ICS 5.
2. Devices shall be heavy-duty, watertight, and corrosion-resistant, and sized to 30 mm.
3. All devices contacts shall be rated 10 amps at 600V.
4. Selector Switches:
  - a. Standard operating lever, lockable in OFF position.
  - b. Maintained contacts, unless noted otherwise.
  - c. Contact arrangement as indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
5. Indicating Lights:
  - a. LED, full-voltage, with push-to-test function.

- b. Color as indicated in control diagrams on drawings.
- 6. Pushbuttons:
  - a. Momentary contacts, unless noted otherwise.
  - b. Color:
    - 1) Black for ON, START, RUN OPEN, or RUN CLOSE.
    - 2) Red for OFF or STOP.
  - c. Contact arrangement as indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
  - d. Emergency stop pushbuttons shall be push-to-de-energize, pull-to-reset type, with number of contacts indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
- 7. Nameplates:
  - a. Engraved laminated plastic, black with white core.
  - b. Stainless steel attachment screws.
  - c. Letter Height: 1/8-inch.
  - d. Text Arrangement: No more than 14 characters or spaces per line.
- 8. Manufacturer, or Equal:
  - a. General Electric.
  - b. Square D.
  - c. Eaton.

**P. Uninterruptible Power Supply (UPS):**

- 1. Provide and install a UPS in control panels where indicated to provide power outage ride-through power to control devices in such control panels.
- 2. Each UPS shall maintain power to all of its loads, including non-constant loads, for a minimum of 15 minutes. The equipment submittal shall include sizing calculations which support the unit selected.
- 3. Each UPS shall be of rugged industrial design and DIN rail mountable.
- 4. Each UPS shall have an internal or external battery made by the same manufacturer as the UPS for specific use with the UPS. The battery shall be sized to provide run times as indicated.

5. Nominal output voltage: Same as input voltage.
6. Output voltage regulation: Plus or minus 3 percent load regulation under variations of line and load condition within the ratings of the UPS.
7. Each UPS shall have normally open output contacts for “UPS fault”, “low battery”, and “battery on” that are wired to a local PLC discrete input module, where a PLC is used.

**Q. Programmable Logic Controller (PLC):**

1. Small Systems: Provide a compact, modular microcontroller of the type suitable for controlling a small subsystem.
2. SCADA Cabinet: Provide a compact, modular PLC of the type suitable for controlling a small industrial facility.
3. Each PLC shall be provided with the number and type of inputs and outputs (I/O) and controller memory as required for a complete and operable control system and as indicated on the Contract Documents.
4. Certified or listed to UL 508 requirements or a Nationally Recognized Testing Laboratory (NRTL) equivalent.
5. Power Supply:
  - a. SCADA Cabinet PLC (PLC-090): 24 Vdc.
  - b. Other PLCs: 120 Vac or 24 Vdc, as required to match output voltage of UPS.
6. Communications: Provide one or both of the following:
  - a. Ethernet/IP protocol over one or more RJ45 ports for digital communication. Modbus TCP is not a suitable alternative.
  - b. Modbus RTU protocol over one or more RJ45 ports or RS-485 ports for serial communication.
7. Software: PLC software shall be manufacturer's standard.
8. Manufacturer and model are subject to final approval by OWNER: Provide the following, or equal:
  - a. **Emerson.**
  - b. **Allen Bradley.**
  - c. **Schneider Electric.**

**R. Ethernet Switch:**

1. Ethernet switches shall be industrial managed type and DIN rail- or panel-mounted, as required.
2. Each switch shall be certified or listed to UL 508 requirements or an NRTL equivalent.
3. Transfer Speeds: Minimum of one Gigabit per second (Gbps) over copper.
4. Power Supply: 120 Vac or 24 Vdc.
5. Communication Ports: At a minimum, provide the following at each switch:
  - a. Four RJ45 copper ports with Power over Ethernet (PoE).
6. USB Type B configuration port.
7. Manufacturer, or Equal: **Red Lion; N-Tron series.**

**S. Control Circuit Wiring:**

1. Listed to UL 1063.
2. Wire type and sizes:
  - a. Conductor shall be flexible stranded copper machine tool wire, type MTW, and shall be rated 600 volts.
  - b. Wires for instrument signal circuits and alarm input circuits shall be 14 AWG.
  - c. Other wires, including shielded cables, shall be 16 AWG minimum.
3. Wire Insulation Colors:
  - a. Conductors supplying 24 Vdc power shall have red insulation for positive and black insulation for negative.
  - b. Other conductors shall have gray insulation or vendor's standard.
4. Splicing of wires will not be acceptable.
5. Wiring Across Door Hinge: Use NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
6. Wire connections internal to panel using crimp-on terminations.

**T. Power Supply Wiring:**

1. Listed to UL 44 or UL 93, as applicable.
2. Main power supply entry shall come from below control panel. Provide adequate space for pulling main power conductors from below to land at top of main circuit breaker terminals.

3. Wire Size and Type:
  - a. Stranded copper, type THHN/THWN-2 for #8 AWG and smaller and type XHHW-2 for #6 and larger, with insulation rated for 600 volts.
  - b. Conductors shall be sized in accordance with NFPA 70 for the motor or other load being powered from the control panel.
4. Wire Insulation Colors:
  - a. 480 Vac Conductors: Brown, orange, and yellow for phases A, B, and C.
  - b. 208 Vac Conductors: Black, red, and blue for phases A, B, and C.
  - c. 240 Vac, Single-Phase Conductors: Black and red for line conductors.
  - d. 120 Vac Conductors: Black for line conductors.
  - e. Neutral Conductors: White insulation.
  - f. Ground Conductors: Green insulation or bare copper.

**U. Terminal Blocks:**

1. Components shall be manufactured in accordance with UL 486F and UL 1059.
2. Size components to allow insertion of necessary wire sizes.
3. Capable of termination of control circuits entering or leaving control panel.
4. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
5. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
6. Yoke shall guide all strands of wire into terminal.
7. Current bar shall ensure vibration-proof connection.
8. Terminals:
  - a. Capable of wire connections without special preparation other than stripping.
  - b. Capable of jumper installation with no loss of terminal or rail space.
9. Marking system, allowing use of preprinted or field-marked tags.
10. Rotary 90-degree integral disconnect, allowing separation of signals through terminal block without removal of any wire.
11. Manufacturer, or Equal:

- a. Entrelec; M6/8-STP.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

#### **A. Preparation for Shipment and Shipping:**

1. Panels shall be crated for shipment using a heavy framework and skids.
2. Panel sections shall be cushioned to protect the finish of the panel during shipment. Instruments that are shipped with the panel shall have suitable shipping stops and cushioning material installed to protect parts that could be damaged due to mechanical shock.
3. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
4. Control panel testing and inspection shall be performed prior to shipping.

### **3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING**

#### **A. Wiring Installation:**

1. Wires shall be routed in plastic wireways, except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components.
2. Wiring routed from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.

- B. Wiring routed to control devices on the doors shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.

- C. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on shop drawings. These numbers shall be marked on conductors at every terminal.

### **3.3 TESTING**

#### **A. Inspection and Approval:**

1. Panel fabricator shall conduct the following tests prior to shipment:
  - a. Alarm circuits rung out to determine their operability.
  - b. Electrical circuits checked for continuity and where applicable, operability.

- c. Verify the proper operation of control logic in each mode of control.
- d. Nameplates shall be checked for correct spelling and size of letters.
- e. Any other test required to place the panel in an operating condition.

**B. Field Testing:**

- 1. In accordance with Section 26 01 26 – Electrical Testing.
- 2. Each control panel shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.
- 3. Control Tests: Controlled systems and apparatus shall be operated from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, remote control actions, remote feedback of status and position, and the like.
- 4. Interlocks: Interlocks between the instrumentation and the motor control circuits and packaged equipment controls shall be checked to the maximum extent possible.

- END OF SECTION -

## SECTION 40 90 10 - INSTRUMENTATION FOR PROCESS SYSTEMS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide process instrumentation for the WORK in accordance with this specification and the Contract Documents.
- B. The provisions of this section apply to all instrumentation included in the WORK, except as indicated otherwise.
- C. All process instrumentation is listed in the Instrumentation Schedule under Part 4 – Appendix A of this section.

#### 1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

##### **American Society of Mechanical Engineers (ASME)**

Fluid Meters: Their Theory and Application, 6th ed.

##### **Instrument Society of America Standard (ISA)**

5.1 Instrumentation Symbols and Identification

20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

##### **National Electrical Manufacturers Association (NEMA)**

250 Enclosure for Electrical Equipment (1000 Volts Maximum)

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. **General Submittal Requirements:** Provide the following:
  - 1. Bill of material, with enumerated make and model of all instrumentation included in the WORK.
  - 2. Catalog cuts of bulletins or brochures for each unique instrumentation system.
  - 3. Types of materials and enclosure ratings.
  - 4. Interconnection diagrams that identify external connections between the instrumentation, associated equipment, and equipment provided under other specifications.
  - 5. Nameplates.
  - 6. Power supply requirements.



- C. **Shop Drawings:** Each instrument, transmitter, and analyzer shall be identified with its equipment identification number, as indicated on the drawings.
- D. **Manufacturer's Data:** With the Shop Drawings, furnish certified curves indicating flow versus differential pressure and any other information called for in the individual meter specifications.
- E. **Technical Manual:** Furnish 5 identical copies of complete operation and maintenance instructions of all unique metering and analyzer systems including instrumentation and controls, in accordance with the paragraph "Operational Procedures" in Section 01 33 00.
- F. **Spare Parts List:** The CONTRACTOR shall furnish a list of manufacturer's recommended spare parts.
- G. **Special Tools:** A list of special tools shall be submitted to the ENGINEER.
- H. **Documentation:** After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that all instrumentation systems will operate within the published accuracies and flow ranges and meet these Specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

#### 1.4 SERVICE CONDITIONS

- A. **Ambient Temperature Range:**
  - 1. 50°F to 90°F for indoor equipment.
  - 2. 15°F to 100°F for outdoor equipment.
- B. **Site Elevation:** 2,500 feet above sea level.

#### 1.5 QUALITY ASSURANCE

- A. **Accuracy Requirements:** Unless otherwise indicated, flow meters shall be guaranteed to register flow to an accuracy of plus or minus 2 percent of actual flow throughout the range indicated.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Instrumentation shall be listed or certified by a Nationally Recognized Test Lab (NRTL), such as UL or CSA, for compliance with the appropriate American National Standard.
- B. Discrete signals shall be provided by dry contacts rated for 5 amps at 120 VAC.
- C. Analog signals shall be isolated 4 to 20 mA, two-wire signals, unless noted otherwise.

## 2.2 MAGNETIC FLOWMETERS

- A. Magnetic flowmeter systems shall be of the low frequency, electromagnetic induction type and produce a DC, pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, transmitter and flowmeter grounding rings, where indicated.
- B. Magnetic flow meters and electronics shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- C. **Metering Tube:** The metering tube shall have the following:
  - 1. Meter and Coil Housing: Carbon steel, rated to IP68.
  - 2. Line Size: As shown on Instrumentation Schedule.
  - 3. Flanges: ASME B16.5, Class 150 carbon steel, raised face.
  - 4. Process Media: Raw river water (screened).
  - 5. Process Temperature Range: 32 degrees F to 70 degrees F.
  - 6. Flow Range: As shown on Instrumentation Schedule.
  - 7. Liner: Polyurethane.
  - 8. Finish: Polyurethane coating.
  - 9. Conduit Entry: 1/2-inch NPT.
  - 10. Electrode: Standard stainless steel measurement electrodes.
  - 11. Grounding Options: No grounding rings, reference electrode, or lining protectors required.
- D. **Transmitter:** The microprocessor-based signal converter/transmitter shall have the following:
  - 1. Transmitter Housing: Die-cast aluminum, rated to IP66 and NEMA 250 type 4X, with silicone cover gaskets.
  - 2. Mounting: Remote wall mount.
  - 3. Finish: Polyurethane coating.
  - 4. Conduit Entry: 1/2-inch NPT.
  - 5. Utilize DC pulse technique to drive flux-producing coils.

6. Convert DC pulse signal from the tube to a standard 4 - 20 mA signal into a minimum of 700 ohms.
7. A 6-digit LCD display for flowrate, percent of span, and totalizer.
8. An operator interface consisting of keypads which respond to English text entry.
9. Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
10. Integral low flow cut-off and zero return.
11. Automatic range change.
12. Capable of measuring flow in both directions.
13. Programmable parameters including meter size, full scale Q, magnetic field frequency, primarily constant, time constant.
14. Data retention for a minimum of 5 years without auxiliary main or battery power.
15. Self-diagnostics and automatic data checking.
16. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
17. Utilizes "Smart" technology which employs a hand-held configuration terminal and outputs a digital flow signal superimposed on 4 - 20 mA signal and complies to HART protocol.
18. Can tolerate ambient temperature operating limits of -4 to 140 degrees F (-20 to 60 degrees C).
19. Transmitter Output: 4-20 mA.

**E. Performance Requirements:**

1. Time Constant: 0.5 to 1000 seconds.
2. Accuracy: 0.50 percent of flow rate from 10 to 100 percent of full scale.
3. Repeatability: 0.25 percent of full scale.
4. Isolation: Galvanic or optic.
5. Power consumption: 40 VA maximum at rated voltage.
6. Power supply: 120 Vac, plus or minus 10 percent.

**F. Factory Testing:**

1. Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Testing Standards. The calibration procedure shall conform to the requirements of MIL-STD-45662A. A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20, 40, 60, 80, and 100 percent of the calibrated range shall be submitted to the ENGINEER at least 30 days prior to shipment of meters to the Site.

G. Manufacturer, or Equal:

1. **Emerson/Rosemount**
2. **ABB**
3. **Schneider Electric**
4. **Yokogawa**
5. **Siemens**

## 2.3 SUBMERSIBLE PRESSURE TRANSDUCERS

- A. Transducer shall output scalable water level signal based off hydrostatic pressure/water column measurement principle.
- B. Transducer shall compensate for changes in barometric pressure using a reference vent tube contained in the sensor cable.
- C. Vent tube and sensor cable wiring shall be terminated in a readily accessible local terminal box or control panel.
- D. **Type:** Vented gage.
- E. **Housing:** Stainless steel, rated to IP68.
- F. **Nose Cap:** Ported type.
- G. **Installation:** Stilling well, as indicated on drawings.
- H. **Process Media:** Raw river water.
- I. **Process Temperature Range:** 32 degrees F to 70 degrees F.
- J. **Level Range:** As shown on Instrumentation Schedule.
- K. **Accuracy:** Plus or minus 0.25 percent of full-scale, static.
- L. **Supply Voltage:** 24 Vdc.
- M. **Output:** 4-20 mA.
- N. **Cable:** Polyurethane cable jacket, 2-wire plus vent tube, with overall shield and drain wire. Length as required to reach enclosure containing desiccant without straining cable.

O. **Accessories:**

1. Desiccant filter for vent tube termination.
2. Stainless steel cable hanger.
3. Lightning surge line protector.

P. Manufacturer, or Equal:

1. **TE Connectivity**
2. **Keller America**

2.4 VERTICAL-MOUNT FLOAT LEVEL SWITCHES

- A. Mechanical float type switch with fixed vertical actuation for water level detection.
- B. Switch opens when float is in up position and closes in down position.
- C. **Float Material:** Non-metallic. Buna-N Rubber, or other approved material.
- D. **Stem Material:** Non-metallic. Polypropylene, or other approved material.
- E. **Mounting:** 1/8" NPT male. Installation requirements as shown on Drawings.
- F. **Process Media:** Raw river water.
- G. **Process Temperature Range:** 32 degrees F to 70 degrees F.
- H. **Level Differential:** Approximately 3/4" level differential between switch opening and closing.
- I. **Supply Voltage:** 24 Vdc.
- J. **Switch Designation:** Normally closed.
- K. **Cable/Wire Leads:** Length as required to splice at junction box shown on Drawings.

2.5 SUMP PUMP LEVEL SWITCHES

- A. Provide in accordance with the specific pump being controlled, as specified under Section 44 35 56 – Submersible Sump Pumps.

2.6 FACTORY TESTING

- A. Equipment shall be prepared for operational use in accordance with manufacturer's instructions, including bench test and calibration, where required.
- B. Each item shall be subjected to an operating test over the total range of capability of the equipment. Where applicable, tests shall be conducted in accordance with the Test Code of the Standards of the Hydraulic Institute. The CONTRACTOR shall obtain copies of

factory test certifications and shall notify the ENGINEER one week in advance of all tests to be conducted on Site.

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. The CONTRACTOR shall assemble and install equipment in strict accordance with the manufacturer's published instructions, and under the supervision of the manufacturer's representative, where applicable. Installation shall be accomplished by competent craftsmen in a workmanlike manner.
- B. Instrumentation systems shall be handled, installed, calibrated, tested, and pre-commissioned in accordance with Section 40 90 00 – Process Instrumentation and Control, General.
- C. Flowmeters shall be installed as shown. Wherever possible, all flowmeters shall be installed in such a way to provide the manufacturer's recommended straight approach and straight piping downstream. Meters and shut-off and balancing valves shall be firmly supported from the structure or from the floor with approved supports. Inline meters shall be installed to provide full-line flow and not less than the manufacturer's recommended head at all times.

### **3.2 MANUFACTURER'S SERVICES**

- A. Manufacturer's services and training for flowmeters shall be furnished in accordance with Section 40 90 00 – Process Instrumentation and Control, General.

## **PART 4 -- APPENDIX**

- A. The following Instrumentation Schedule is a compilation of all process instrumentation included in the WORK:

<b>Instrumentation Schedule</b>						
<b>Instrument ID</b>	<b>Instrument Type</b>	<b>Location</b>	<b>Size</b>	<b>Process Media</b>	<b>Measurement Range</b>	<b>Output</b>
FE/FIT-200	Flowmeter, Magnetic	Meter Vault	12" dia	Raw Water	0 – 1,000 gpm	Analog, 4-20 mA
FE/FIT-201	Flowmeter, Magnetic	Meter Vault	20" dia	Raw Water	0 – 4,500 gpm	Analog, 4-20 mA
FE/FIT-202	Flowmeter, Magnetic	Meter Vault	20" dia	Raw Water	0 – 4,500 gpm	Analog, 4-20 mA
FE/FIT-203	Flowmeter, Magnetic	Meter Vault	12" dia	Raw Water	0 – 750 gpm	Analog, 4-20 mA
LE-200	Pressure Transducer, Submersible	Intake Structure	N/A	Raw Water	0 – 5 ft W.C.	Analog, 4-20 mA
LE-200	Pressure Transducer, Submersible	Intake Structure	N/A	Raw Water	0 – 5 ft W.C.	Analog, 4-20 mA

LSL-280	Level Switch, Sump Pump	Meter Vault – Pump Off	N/A	Sump Water	As shown	Discrete, N.O.
LSH-280	Level Switch, Sump Pump	Meter Vault – Pump On	N/A	Sump Water	As shown	Discrete, N.O.
LSH-281	Level Switch, Sump Pump	Meter Vault – Alarm High Level	N/A	Sump Water	As shown	Discrete, N.O.
LSL-300	Level Switch, Vertical Float	Coho Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-500	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-501	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-502	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-503	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-660	Level Switch, Sump Pump	Waste Drain Wet Well – Pumps Off	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-660	Level Switch, Sump Pump	Waste Drain Wet Well – Lead Pump On	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-661	Level Switch, Sump Pump	Waste Drain Wet Well – Lag Pump On	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-662	Level Switch, Sump Pump	Waste Drain Wet Well – Alarm High Level	N/A	Waste Drain	As shown	Discrete, N.O.

- END OF SECTION -

## **SECTION 40 90 18 - VENDOR PACKAGE CONTROL SYSTEMS**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide control panels for vendor and manufacturer package equipment, complete and operable, in accordance with the Contract Documents. Control panels supplied by vendors or manufacturers shall meet all applicable requirements of this specification and the Contract Documents.
- B. This section specifically applies to the following systems and their associated appurtenances:
  - 1. Traveling Screens TRS-200 and TRS-201.
  - 2. Booster Pumps P-380, P-580, and P-680.
- C. Each control system shall consist of the following electrical components which are specified under this section:
  - 1. Local control panel, with or without programmable logic controller (PLC) or micro-controller capability, and including the following components:
    - a. Main circuit breaker and externally operable disconnect switch.
    - b. Combination, full-voltage, starter(s).
    - c. All controllers, control relays, pilot devices, and other devices internal to the control panel required for a complete and operable system.
    - d. Input/output (I/O) interfaces with the SCADA PLC, as indicated on the control diagrams on the drawings, to allow for complete operability and monitoring of the gate from a remote location.
- D. Interconnecting wiring and raceway shall be provided under Division 26.
- E. All structural and mechanical components of the controlled apparatus are specified elsewhere, unless noted otherwise.
- F. In general, the provisions of Division 26 apply to materials furnished under this section. Where the requirements of this section conflict with Division 26 requirements, only the requirements of this section shall apply.

#### **1.2 RELATED SECTIONS**

- A. Section 35 79 13 – Traveling Belt Intake Screen
- B. Section 44 35 04 – Packaged Booster Pump System



### 1.3 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

#### **National Electrical Manufacturers Association (NEMA)**

AB 1	Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
ICS 1	Industrial Control and Systems: General Requirements
ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
ICS 5	Control Circuit and Pilot Devices

#### **National Fire Protection Association (NFPA)**

70	National Electrical Code (NEC)
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#### **Underwriters Laboratories, Inc. (UL)**

44	Thermoset-Insulated Wires and Cables
486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
486F	Bare and Covered Ferrules
489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
508	Standard for Industrial Control Equipment
508A	Standard for Industrial Control Panels
1059	Standard for Terminal Blocks
1063	Standard for Machine-Tool Wires and Cables

### 1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. All panel drawings shall, as a minimum, be 11 inches by 17 inches and data sheets and manufacturer specification sheets shall be 8-1/2 inches by 11 inches.
- C. **Preliminary Submittal:** The CONTRACTOR shall submit schematic and elementary diagrams for the control panel a maximum of 60 days after Notice to Proceed that clearly demonstrates the functionality required by the control diagrams in the drawings.
- D. After acceptance of Preliminary Submittal, the CONTRACTOR shall submit a control panel engineering submittal (CPES) for the control panel and enclosure. The submittal shall have the following contents:
1. **Bill of material**, with enumerated make and model of all devices used in construction of the control panel.

**2. Product data:**

- a. Control relays and time delay relays.
- b. Motor contactors and protective devices.
- c. Door-mounted pilot devices (control switches, indicating lights, pushbuttons, etc.).
- d. Circuit breakers and fuse blocks.
- e. Digital meters.
- f. Control power transformers.
- g. Power, signal, and control wiring.
- h. Wireways.
- i. Terminal blocks.
- j. Enclosure data:
  - 1) Gauge and type of steel to be used for fabrication.
  - 2) NEMA 250 type.
  - 3) Backpanel size and color.
  - 4) Panel door handle, lock, and hinge mechanism.
  - 5) Interlock mechanism between panel disconnect and circuit breaker.
  - 6) Vents, fans, and cooling equipment.
  - 7) Panel heat dissipation calculations.
  - 8) Mounting details.
  - 9) Lifting lug locations.
  - 10) Enclosure finish.
  - 11) Nameplate schedule.
  - 12) Print pocket location.

**3. Internal and external panel arrangements:**

- a. Dimensional drawings for interior and exterior of enclosure, with matching enumeration to devices in bill of materials.

- b. Front panel layout drawing.
- c. Backpanel arrangement drawing.
- 4. **Schematic and elementary diagrams**, as shown in Preliminary Submittal. Changes to diagrams are subject to OWNER'S approval.
- 5. **Interconnection diagrams** that identify external connections between the control panel/control panel devices and associated equipment. These diagrams shall indicate terminal block assignments for interconnections.

**E. Control Panel As-Built:**

- 1. Prior to Field Acceptance Testing, the CONTRACTOR shall submit an as-built set of the CPES for review.
- 2. After acceptance of the completed WORK by the OWNER, the CONTRACTOR shall furnish the final accepted CPES as-built set to the OWNER:
  - a. One electronic set in format preferred by OWNER.
  - b. Two hard copy sets, size as indicated above.

**1.5 QUALITY ASSURANCE**

- A. Control panels shall be fabricated and wired in accordance with UL 508A and shall bear the UL label.

**PART 2 -- PRODUCTS**

**2.1 CONTROL PANEL ENCLOSURES**

- A. Control panel enclosures supplied with package systems shall meet the requirements of Section 40 90 05 – Control Enclosures and Devices.

**2.2 CONTROL DEVICES AND COMPONENTS**

- A. All control devices and components supplied with package systems shall meet the requirements of Section 40 90 05 – Control Enclosures and Devices.

**PART 3 -- EXECUTION**

**3.1 GENERAL**

**A. Preparation for Shipment and Shipping:**

- 1. Panels shall be crated for shipment using a heavy framework and skids.
- 2. Panel sections shall be cushioned to protect the finish of the panel during shipment. Instruments that are shipped with the panel shall have suitable shipping stops and cushioning material installed to protect parts that could be damaged due to mechanical shock.

3. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
4. Control panel testing and inspection shall be performed prior to shipping.

B. **Pilot Devices:** Use heavy-duty, watertight, corrosion-resistant type.

### 3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

#### A. **Wiring Installation:**

1. Wires shall be routed in plastic wireways, except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components.
  2. Wiring routed from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.
- B. Wiring routed to control devices on the doors shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.
- C. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on shop drawings. These numbers shall be marked on conductors at every terminal.

### 3.3 TESTING

#### A. **Inspection and Approval:**

1. Panel fabricator shall conduct the following tests prior to shipment:
  - a. Alarm circuits rung out to determine their operability.
  - b. Electrical circuits checked for continuity and where applicable, operability.
  - c. Verify the proper operation of control logic in each mode of control.
  - d. Nameplates shall be checked for correct spelling and size of letters.
  - e. Any other test required to place the panel in an operating condition.

#### B. **Field Testing:**

1. Each control panel shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.
2. Measure the insulation resistance of starter phase-to-phase and phase-to-ground with the starter contacts closed and the breaker open.

3. The test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.
4. Control Tests: Controlled systems and apparatus shall be operated from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, remote control actions, and remote feedback of status and position.
5. Interlocks: Interlocks between the instrumentation and the motor control circuits and packaged equipment controls shall be checked to the maximum extent possible.

- END OF SECTION -

## SECTION 43 00 00 - EQUIPMENT GENERAL PROVISIONS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide equipment and appurtenant WORK, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to equipment throughout the Contract except where otherwise indicated.
- C. **Equipment Arrangement:** Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment. **It shall be the CONTRACTOR's responsibility to develop the details necessary to design and construct equipment installation systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.**

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

- A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:
  - 1. American Society for Testing and Materials (ASTM).
  - 2. American National Standards Institute (ANSI).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. American Water Works Association (AWWA).
  - 5. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
  - 6. American Welding Society (AWS).
  - 7. National Fire Protection Association (NFPA).
  - 8. Federal Specifications (FS).
  - 9. National Electrical Manufacturers Association (NEMA).
  - 10. Manufacturer's published recommendations and specifications.

## 11. General Industry Safety Orders (OSHA).

### B. The following standards are referenced in this Section:

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ANSI S12.6	Methods for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B31.1	Power Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Carbon Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

## 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.
- C. **Spare Parts List:** The CONTRACTOR shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.
- D. Certifications that equipment and equipment supports comply with seismic and wind design criteria from Code.

## 1.4 QUALITY ASSURANCE

- A. **Costs:** The CONTRACTOR shall perform and pay the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives.

1. The CONTRACTOR shall be required to provide and pay for the cost of providing all temporary utilities, including electrical power and utility water, related to the startup, testing, and instruction services of equipment.
  2. If electrical power or utility water is specified to be provided or derived from permanent OWNER's facilities, the OWNER shall be responsible to pay for the consumed electricity and utility water.
- B. **Assistance by OWNER's Staff:** One of the OWNER's on-site staff will be available to provide operational assistance related to support facilities only, during field startup and testing of new equipment (TBD).
- C. **Inspection** The CONTRACTOR shall inform the local county and state authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, and related items to obtain required permits and certificates.
1. All fees required for such local and state permits and inspections shall be paid for by CONTRACTOR.
- D. **Quality and Tolerances:** Tolerances and clearances shall be as shown on the approved Shop Drawings and shall meet the following criteria:
1. Machine WORK shall be of high-grade workmanship and finish, with proper consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.
  2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER'S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR'S responsibility as part of the WORK.
  3. Materials shall meet the physical and mechanical properties in accordance with the reference standards.
- E. **Machine Finish:** The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.



2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
  3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
  4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.
- F. **Manufacturer's Experience:** Equipment manufacturer shall have a record of at least 5 years of successful, trouble-free operation in similar applications and of size equal to or greater than the equipment required in this Contract. For any "or Equal" supplier or manufacturer submitted upon by the CONTRACTOR, the ENGINEER and OWNER shall maintain the right to require the CONTRACTOR to provide at least three (3) prior installation references (with contact names and phone numbers) who may be contacted by the ENGINEER for verification of acceptable performance.

## PART 2 -- PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. **Noise Level:** When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 105 dBA for one-hour exposure per day.
- B. **Drive Trains and Service Factors:** Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Reciprocating Air Compressors multi-cylinder single cylinder	2.0 2.0	Heavy Shock Heavy Shock
Pumps centrifugal or rotary reciprocating progressing cavity	1.0 1.8 1.0	Uniform Moderate Shock Uniform
Centrifugal Fans	1.0	Uniform
Cranes or Hoists	1.25	Moderate Shock

C. **Mechanical Service Factors**

	<b>Mechanical Service Factors</b>	
	<b>Electric Motor</b>	<b>Internal Combustion Engine</b>
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

D. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear manufacturer sizing information.

E. **Electric Motor Service Factors.** Service factors of electric motors shall be a minimum of 1.15 unless noted otherwise in Section 26 05 10 - Electric Motors.

F. Where load classifications are not indicated, service factors shall be for standard load classifications and for flexible couplings.

G. **Welding:** Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.
2. Latest revision of AWWA C206.
3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
4. 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. Qualification of welders shall be in accordance with the AWS Standards.
5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

H. **Protective Coating:** Equipment shall be painted or coated in accordance with Section 09 96 00 - Protective Coatings, unless otherwise indicated. Non-ferrous metal and

corrosion-resisting, rotating or moving steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

- I. **Protection of Equipment:** Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather-tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized, and shafts shall be rotated. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, and recoated to restore it to original condition.
- J. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.
- K. **Controls:** Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

## 2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. **Equipment Supports.** Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed by the Supplier for worst case static, dynamic, wind, and seismic loads. The design horizontal seismic forces shall be the greater of that noted in the general structural notes (see Contract Drawing GS001 or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise indicated.

Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings.

- 1. Wall-mounted equipment weighing more than 250 pounds, or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.
- 2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.
- 3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a minimum

factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

**B. Equipment Foundations.**

1. Mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 4-inch high concrete equipment bases, unless otherwise indicated, and shall extend at least 4-inches further horizontally than the extent of the equipment frame or skid.
2. Estimates of the required equipment foundations are indicated on the Contract Drawings. The CONTRACTOR through the equipment manufacturer shall verify the size and weight of equipment foundations to insure compatibility with equipment.

- C. **Anchors.** Anchor bolts shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork. CONTRACTOR shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit anchor bolt criteria, sizes, and installation methods with the Shop Drawings.

**2.3 COUPLINGS**

- A. Mechanical couplings shall be provided between the driver and the driven equipment. 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. Unless otherwise indicated or recommended by the equipment manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	Coupling Type
Horizontal and end suction pumps	Gear or flexible spring

- B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, 2 sets of universal type couplings shall be provided.
- D. **Taper-Lock** or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

**2.4 SHAFTING**

- A. **General:** Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the

diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

- B. **Design Criteria:** Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of 2 in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.
- C. **Materials:** Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.
  - 1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
  - 2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
  - 3. Other grades of carbon steel alloys shall be suitable for service and load.
  - 4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- D. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

## 2.5 GEARS AND GEAR DRIVES

- A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the ENGINEER.
- B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.
- C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the

service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two positive seals to prevent oil leakage.

- E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.
- F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the CONTRACTOR shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

## 2.6 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains meeting ASME Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.
- C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

## 2.7 SPROCKETS

- A. **General:** Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.
- B. **Materials:** Unless otherwise indicated, materials shall be as follows:
  - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
  - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
  - 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.
- C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
- E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with **Taper-Lock** bushings as required.
- F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

## 2.8 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ASME, MPTA, and RMA Standards.
- B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.
- C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
- D. To facilitate installation and disassembly, sheaves shall be provided complete with **Taper-Lock** or **QD** bushings as required.
- E. Finish bored sheaves shall be complete with keyseat and set screws.
- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

## 2.9 DRIVE GUARDS

- A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform to the Division of Industrial Safety General Industrial Safety Orders latest edition. The guards shall be constructed of minimum 10-gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

## 2.10 BEARINGS

- A. Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).
- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.
- C. **Bearing Lubrication.**
  - 1. Re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
  - 2. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance
- D. **Anti-Friction Type Bearing Life:** Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of five years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life, years	L-10 Design Life, hours
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	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

- E. **Bearing Housings.** Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

## 2.11 PIPING CONNECTIONS

- A. **Pipe Hangers, Supports, and Guides:** Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 23 02 - Pipe Supports.
- B. **Flanges and Pipe Threads:** Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 23 00 - Piping, General.
- C. **Flexible Connectors:** Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 14 23 00. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

## 2.12 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

## 2.13 TOOLS AND SPARE PARTS

- A. **Tools:** The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by **Snap On, Crescent, Stanley**, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.



## **PART 3 -- EXECUTION**

### **3.1 SERVICES OF MANUFACTURER**

- A. **Inspection, Startup, and Field Adjustment:** Where required by individual sections, an authorized, experienced, and competent service representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to witness or perform 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 equipment
  2. Inspection, checking, and adjusting the equipment and approving its installation
  3. Startup and field testing for proper operation, efficiency, and capacity
  4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements
- B. **Instruction of the OWNER'S Personnel**
1. Where required by the individual equipment sections, an authorized training representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
  2. The representative shall have at least 2 years experience in training. A resume of the representative shall be submitted.
  3. Training shall be scheduled 3 weeks in advance of the scheduled session.
  4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the ENGINEER shall be incorporated into the material.
  5. The training materials shall remain with the trainees after the session.
  6. The OWNER may videotape the training for later use by the OWNER'S personnel.
- C. **Vibration Monitoring:** For the equipment types listed in paragraph 1.3D, the CONTRACTOR shall arrange for at least 2 Site visits by the manufacturer's specialist during testing of the equipment covered by torsional and vibration analysis submittals to measure the amount of vibration and prepare written recommendations for keeping the vibration within acceptance limits. If vibration readings exceed the specified or the applicable referenced standard vibration limits for the type of equipment, the CONTRACTOR shall make necessary corrections for the equipment to meet the acceptance criteria.

### 3.2 INSTALLATION

- A. **General:** Equipment shall be installed in accordance with the manufacturer's written recommendations.
- B. **Alignment:** Equipment shall be field tested to verify proper alignment.

### 3.3 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.
- B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide material and labor necessary for a complete installation as required by the manufacturer.

### 3.4 FIELD ASSEMBLY

- A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with **Never Seize** compound or equal.

### 3.5 WELDING

- A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

### 3.6 FIELD TESTS

- A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.
- B. The following field testing shall be conducted:
  - 1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.
  - 2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.
  - 3. Operate equipment indicated in Section 01 75 00.
- C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER or OWNER of the test schedule no less than 3 Days in advance.
- D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

- END OF SECTION -



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## SECTION 43 25 00 - VALVES, GENERAL

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 – Equipment General Provisions, apply to the WORK of this Section.
- C. The provisions of this Section shall apply to valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- D. Where a valve is to be supported by means other than the piping to which it is attached, the CONTRACTOR shall obtain from the valve manufacturer a design for support and foundation that satisfies the criteria in Section 43 00 00. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.
- E. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.
- F. **Single Manufacturer:** Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings:** Shop Drawings shall contain the following information:
  - 1. Valve name, size,  $C_v$  factor, pressure rating, identification number (if any), and specification section number.
  - 2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
  - 3. Cavitation limits for control valves.
  - 4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Data in accordance with Section 26 05 10 – Electric Motors for electric motor-actuated valves.
  6. Complete wiring diagrams and control system schematics.
  7. Valve Labeling: A schedule of valves to be provided with stainless steel tags, indicating in each case the valve location and the proposed wording for the tag.
- C. **Technical Manual:** The Technical Manual shall contain the required information for each valve.
- D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.
- E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

## PART 2 -- PRODUCTS

### 2.1 PRODUCTS

- A. **General:** Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.
- B. **Valve Actuators:** Unless otherwise indicated, actuators shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
- C. **Protective Coating:** The exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 96 00 – Protective Coating. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- D. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 40 23 01 – Piping Identification and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.
- E. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valve rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
  2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves. Resilient-seated valves shall be drop-tight.
  3. **Performance Testing:** Valves shall be shop-operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.
- F. **Certification:** Prior to shipment, the CONTRACTOR shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.
- G. **Valve Marking:** Valve bodies shall be permanently marked in accordance with MSS SP25 – Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

## 2.2 MATERIALS

- A. **General:** Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A48 – Gray Iron Castings, Class 30, or to ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  2. **Ductile Iron:** ASTM A536 – Ductile Iron Castings, or to ASTM A395 – Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
  3. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A351 – Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
  4. **PVC:** Poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

## 2.3 VALVE CONSTRUCTION

- A. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated and be rated for the maximum temperature and pressure to which the valve will be subjected.
- B. **Valve End Connections:** Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.
- C. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- D. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal.
- E. **Stem Guides:** Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.
- F. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.
- G. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 –Miscellaneous Metalworks.

## 2.4 VALVE ACCESSORIES

- A. Valves shall be furnished complete with the accessories required to provide a functional system.

## 2.5 SPARE PARTS

- A. The CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

## 2.6 MANUFACTURERS

- A. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than five years in the manufacture of the valves indicated.



## PART 3 -- EXECUTION

### 3.1 VALVE INSTALLATION

- A. **General:** Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.
- B. **Access:** Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

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## SECTION 43 25 01 - VALVE AND GATE ACTUATORS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.
- C. **Unit Responsibility:** The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.
- D. **Single Manufacturer:** Where two or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 43 25 00 – Valves, General.
- B. **Shop Drawings:** Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.
- C. **Calculations:** Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The CONTRACTOR shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 – Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.
- B. **Manufacturers:** Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are

furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.

- C. **Materials:** Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.
- D. **Actuator Mounting and Position Indicators:** Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.
- E. **Standard:** Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C540 – Power-Actuating Devices for Valves and Slide Gates.
- F. **Functionality:** Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26 and instrumentation equipment indicated in Section 40 90 01 – Process Instrumentation and Control, General.
- G. Fasteners shall be in accordance with Section 05 50 00 – Miscellaneous Metalwork.
- H. Protective coatings shall be in accordance with Section 09 96 00 – Protective Coatings.

## 2.2 MANUAL ACTUATORS

- A. **General:** Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.
- B. **Buried Valves:** Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local Utility Company or the ENGINEER. Wrench nuts shall comply with AWWA C500 – Metal-Seated Gate Valves for Water Supply Service.
- C. **Floor Boxes:** Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

- D. **Tee Wrenches:** Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground shall fit the operating nuts.
- E. **Manual Worm Gear Actuator:** The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof.
- F. **Traveling-Nut Actuator:** The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. Valve and gate actuators and accessories shall be installed in accordance with Section 43 25 00 – Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

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## SECTION 43 25 02 - BUTTERFLY VALVES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 – Equipment General Provisions apply to this Section.
- C. The requirements of Section 43 25 00 – Valves, General apply to this Section.
- D. The requirements of Section 43 25 01 – Valve and Gate Actuators apply to this Section.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.
- B. Shop Drawings
  - 1. Complete Shop Drawings of butterfly valves and actuators.
  - 2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
  - 3. Dynamic seating and unseating torque for any motor actuated valves.
  - 4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.
  - 5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

#### 1.3 QUALITY ASSURANCE

- A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

### PART 2 -- PRODUCTS

#### 2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

- A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for fresh water service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated.

1. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B.
  2. Valves 30 inches through 72-inches shall be of the class indicated.
  3. Valves larger than 72-inches shall be of the class indicated, designed in accordance with the intent of AWWA C504.
- B. **Valve Schedule.** Valves of 4-inch diameter and larger shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedule on **Contract Sheet GM-002 thru GM-004**. If the operating conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.
- C. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A 48, Class 40 or Gray iron, ASTM A 126, Class B, or Ductile iron, ASTM A 536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 304
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09 96 00 – Protective Coatings
Hardware (Bolts/Nuts)	Per Specification 05 50 00



- D. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator or locking lever. Screw-type (traveling nut) actuators will not be permitted for buried or submerged valves.
- E. **Ferrous Surface Coating:** All corrosive ferrous surfaces of valves 3-inches and larger, exclusive of flange faces, shall be properly primed and epoxy-coated per the Manufacturer's standard liquid-applied epoxy coating system. For buried valves, all ferrous surfaces, exclusive of flange faces, shall be given proper primer and fusion-bonded epoxy coatings, per AWWA C550, for buried service.
- F. **Manufacturers, or Equal**
  - 1. Clow / M & H Valve Company
  - 2. DeZURIK Water Controls, Corporation
  - 3. Henry Pratt / Mueller Company. (Series 2FI for valves 20" dia and smaller indoors. Series "Groundhog" for all buried valves.)
  - 4. Kennedy Valve
  - 5. Val Matic / American Darling. (Series 2000 for valves 20" dia and smaller – indoors, and Series 2030 for all buried valves)
  - 6. Rodney Hunt Company (24-inches and larger)

## 2.2 BURIED BUTTERFLY VALVES

- A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for freshwater service having a pH range from 6 to 9 and temperature range from 35 to 60 degrees F shall conform to AWWA C504 and be as indicated.
  - 1. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 30-inches shall be rated for either Class 75B or Class 150B with actuator sized for Class 150B.
- B. **Valve Schedule.** Valves of 3-inch diameter and larger shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedules on **Contract Drawings**. If the operating conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.
- C. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A48, Class 40 or Gray iron, ASTM A126, Class B, or Ductile iron, ASTM A536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A240 or A276, Type 316
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A240 or A276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self-lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	See Section 09 96 00 – Protective Coatings
Hardware (Bolts/Nuts)	Per Specification 05 50 00

- D. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.
- E. **Worm Gear Actuators:** Valves 30-inches and larger, as well as submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.
- F. **Ferrous Surface Coating:** All corrosive ferrous surfaces of valves 3-inches and larger, exclusive of flange faces, shall be properly primed and epoxy-coated per the Manufacturer's standard liquid-applied epoxy coating system. For buried valves, all ferrous surfaces, exclusive of flange faces, shall be given proper primer and fusion-bonded epoxy coatings, per AWWA C550, for buried service.
- G. **Manufacturers, or Equal**
1. **Clow / M & H Valve Company**
  2. **DeZURIK Water Controls, Corporation**
  3. **Henry Pratt / Mueller Company.** (Series 2FI for valves 20" dia and smaller indoors. Series "Groundhog" for all buried valves.)

4. **Val Matic / American Darling.** (Series 2000 for valves 20" dia and smaller – indoors, and Series 2030 for all buried valves)

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION**

- A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 25 00.

- END OF SECTION -

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## SECTION 43 25 03 - CHECK VALVES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

The requirements of Section 43 25 00 – Valves, General apply to this Section.

#### 1.2 CONTRACTOR SUBMITTALS

Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.

### PART 2 -- PRODUCTS

#### 2.1 SWING CHECK VALVES (3-INCHES AND LARGER)

**General:** Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C508 – Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

**Body:** The valve body and cover shall be of cast iron conforming to ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 125, or be mechanical joint ends, as indicated.

**Disc:** The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B584 – Copper Alloy Sand Castings for General Applications.

**Seat and Rings:** The valve seat and rings shall be of bronze conforming to ASTM B584 or B 148 – Aluminum-Bronze Castings or of Buna-N.

**Hinge Pin:** The hinge pin shall be of bronze or stainless steel.

**Dashpot:** A bottom-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2-stage closing rates: For the 2-stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over

oil) and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve. There shall be a provision for disconnecting each dashpot from the valve for servicing, without removal of the valve.

**Limit Switches:** Limit switches shall be provided on check valve swing arms where indicated. Switches shall be roller lever rotary actuated type, with contacts rated for 10 amp at 120 VAC. Switches shall be located to actuate when the check valve is fully closed and deactivate when the valve begins to open. Switches shall be **Honeywell Microswitch Model 1LS1, Square D 9007 C**, or equal.

Manufacturers, or Equal

**APCO (Valve and Primer Corp.)**

**Kennedy Valve**

**Mueller Company**

**Stockham Valves and Fittings**

**Golden Anderson**

## 2.2 SILENT CHECK VALVES (10-INCHES AND SMALLER)

**General:** Check valves shall be of the silent wafer check style

**Body:** The valve body, bushing, spring, poppet and seat ring shall be of Type 316 stainless steel conforming to NSF 61, suitable for mounting between ANSI 125 lb. flat faced companion flanges. No yellow metals allowed.

**O- Rings:** The O-rings shall be EPDM.

Manufacturers, or Equal

- a. **Valmatic**
- b. **Flowmatic 888S6**
- c. **Mueller Company**
- d. **Stockham Valves and Fittings**
- e. **Golden Anderson**

## 2.3 PLASTIC SWING OR WYE-CHECK VALVES

**General:** Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

**Construction:** The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut

positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

Manufacturers, or Equal

**ASAHI-AMERICA**

**George Fischer, Inc.**

**Spears Mfg. Co.** (Plastic Swing Check only)

## 2.4 SLANTING DISC CHECK VALVES

**General:** Slanting disc check valves for water service shall have a seating angle of approximately 55 degrees. Valves shall have replaceable seat rings and disc rings. The water passage cross-sectional area shall be equal to the full pipe area. Valves shall have sufficient clearance around the pivot pins to permit free seating of the disc without binding and shall be guaranteed not to stick in the closed position. Slanting disc check valves shall have position indicators and 2 flanged connections for attachment of dashpots or hydraulic snubbers. The valves shall be designed for a water working pressure of 150 psi, unless otherwise indicated.

**Body:** The valve body shall be of cast iron conforming to ASTM A48 – Gray Iron Castings, or A126, Class B, with flanged ends conforming to ASME B16.1, Class 125, unless otherwise indicated.

**Disc:** The valve disc shall be designed with an "airfoil" configuration of cast iron or ductile iron, with bronze seating face, except for valves 10-inches or smaller, which may have solid bronze or aluminum bronze discs. The disc shall be partially balanced with a short travel to resist slamming.

**Seat Ring:** The seat ring shall be of centrifugally-cast bronze, aluminum bronze, or stainless steel, with beveled edges, firmly clamped or screwed into the valve body.

**Pins:** The pivot pins and bushings shall be of stainless steel, bronze, or aluminum bronze to allow free movement of the disc without binding.

**Dashpot:** A bottom-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2 stage closing rates. For the 2-stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and also to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over oil) and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve.

There shall be a provision for disconnecting each dashpot from the valve for servicing, without removal of the valve.

**Limit Switches:** Limit switches shall be provided on check valve swing arms where indicated. Switches shall be roller lever rotary-actuated type with contacts rated for 10 amp at 120 volts. Switches shall be located to actuate when the check valve is fully closed and deactivate when the valve begins to open. Switches shall be **Honeywell Microswitch Model 1LS1, Square D 9007 C**, or equal.

Manufacturers, or Equal

**APCO (Valve and Primer Corporation)**

**Crane Company** (Without Dashpot, Only)

**VAL-MATIC (Valve and Manufacturing Corporation)**

## 2.5 METALLIC BALL SEWAGE CHECK VALVES

- A. **General:** Metallic ball check valves for sewage service, in sizes up to 24-inches, shall be used for vertical up-flow conditions and horizontal positions only.
- B. **Construction:** The valve shall be designed with non-clogging feature for raw sewage. The ball shall be guided to and from its seat by smooth ribs integrally cast into the housing wall. An internal clog-proof design shall insure a completely free and unobstructed flow with no projections or pockets to trap solid material. The valve body and cover shall be of cast or ductile iron and be epoxy-coated suitable for the service condition. Units shall have flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150. Ball shall be made of hollow metal with vulcanized Buna-N rubber or Hypalon cover suitable for the service. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.
- C. Manufacturers, or Equal
  - 1. **Flygt (HDL)**
  - 2. **Golden Anderson**

## PART 3 -- EXECUTION

### 3.1 GENERAL

Valves shall be installed in accordance with provisions of Section 43 25 00 – Valves, General.

- END OF SECTION -



## SECTION 43 25 04 - BALL VALVES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 25 00 – Valves, General apply to this Section.
- C. The requirements of Section 43 25 01 – Valve and Gate Actuators apply to this Section.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.

### PART 2 -- PRODUCTS

#### 2.1 METAL BALL VALVES (4-INCHES AND SMALLER)

- A. **General:** Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 43 25 01 – Valve and Gate Actuators.
- B. **Body:** Ball valves up to and including 1-1/2 inches in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 4-inches in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.
- C. **Balls:** The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.
- D. **Stems:** The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.
- E. **Seats:** The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.
- F. Manufacturers, or Equal
  - 1. **Conbraco Industries, Inc. (Apollo)**
  - 2. **ITT Engineered Valves**
  - 3. **Neles-Jamesbury, Inc.**
  - 4. **Watts Regulator**
  - 5. **Worcester Controls**

## 2.2 PLASTIC BALL VALVES

- A. **General:** Plastic ball valves shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific application. Valves shall have manual actuators in accordance with Section 43 25 01 - Valve and Gate Actuators, unless otherwise indicated.
- B. **Construction:** Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and Teflon seats. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.
- C. Manufacturers, or Equal
  - 1. **ASAHI-America**
  - 2. **George Fischer, Inc.**
  - 3. **NIBCO Inc., (Chemtrol)**
  - 4. **Plast-O-Matic Valves, Inc.**
  - 5. **Spears Mfg. Co.**
  - 6. **Watts Regulator**
  - 7. **Hayward**

## PART 3 -- EXECUTION

### 3.1 GENERAL

- A. Valves shall be installed in accordance with Section 43 25 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

## SECTION 43 25 06 - GATE VALVES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

The CONTRACTOR shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

The requirements of Section 43 25 00 – Valves, General apply to this Section.

The requirements of Section 43 25 01 - Valve and Gate Actuators apply to this Section.

#### 1.2 CONTRACTOR SUBMITTALS

Furnish submittals in accordance with Section 43 25 00 – Valves, General and Section 01 33 00 – Contractor Submittals.

### PART 2 -- PRODUCTS

#### 2.1 RESILIENT-SEATED GATE VALVES

- A. **General:** Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the ENGINEER.
- B. **Construction:** Resilient-seated gate valves shall conform to AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service. The valves shall be suitable for a minimum design working water pressure of 150 psig with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 of AWWA C515. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C515.
- C. **Pressure Ratings:**
  - 1. AWWA C515 valves 3- through 36-inch with outside screw-and-yoke (OS&Y) rising stem and 3- through 16-inch for non-rising-stem (NRS), shall be rated for 200 psig minimum design working water pressure.
- D. **Protective Coating:** Valves shall be factory coated in accordance with Section 09 96 00 - Protective Coating. The CONTRACTOR shall submit a test report from a coating inspector that the valve body coating is holiday-free. The CONTRACTOR shall be aware that if required, it shall retain the services of a third-party coating applicator to achieve the holiday-free requirement.
- E. **Actuators:** Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 43 25 01.
- F. Manufacturers, or Equal

- 1. **Mueller Company**

2. **M & H**

3. **Clow**

2.2 PLASTIC GATE VALVES (1.5 TO 12-INCHES)

- A. **Construction:** Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined wedges for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a cold-water pressure rating of 150 psig for sizes 1.5 through 8-inches, and 110 psig for size 10 through 12-inches.
- B. **Actuators:** Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 43 25 01.
- C. Manufacturers, or Equal
  - 1. **ASAHI/America**
  - 2. **Spears Mfg. Co.**

**PART 3 -- EXECUTION**

3.1 GENERAL

- A. Gate valves shall be installed in accordance with the provisions of Section 43 25 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

## SECTION 43 25 42 - MISCELLANEOUS VALVES

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 25 00 – Valves, General, apply to this Section.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

### PART 2 -- PRODUCTS

#### 2.1 AIR-VACUUM AND AIR-RELEASE VALVES

- A. **Air and Vacuum Valves:** Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.
- B. **Air-Release Valves:** Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.
- C. **Combination Air Valves:** Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.
- D. Manufacturers, or Equal
  - 1. **APCO (Valve and Primer Corporation)**
  - 2. **Crispin Valves**
  - 3. **GA Industries**
  - 4. **Val-Matic (Valve and Manufacturing Corporation)**

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

- A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, wherever there is any danger of contamination, and where indicated.
- B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 43 25 00.
- C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

- END OF SECTION -

## **SECTION 43 30 56 - HYDRAULIC GATES, GENERAL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide hydraulic gates with appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to flap gates, slide gates, stop gates, cast iron slide gates, and shear gates, except where otherwise indicated in the Contract Documents.
- C. Single Manufacturer
  - 1. The CONTRACTOR shall assign to a single manufacturer responsibility for the furnishing and functional operation of the hydraulic gates, including operators and accessories.
  - 2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

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

AWWA C560	Cast Iron Slide Gates
AWWA C561	Stainless Steel Slide Gates
AWWA C562	Aluminum Slide Gates
AWWA C563	Composite Slide Gates
AWWA C 513	Open Channel Fabricated Metal Slide Gates
ASTM A 276	Stainless Steel Bars and Shapes
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

#### **1.3 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with SECTION 01 33 00 - CONTRACTOR SUBMITTALS.
- B. Shop Drawings
  - 1. Submit Shop Drawings of hydraulic gates as indicated in their respective Section.

C. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

D. Certification

1. The CONTRACTOR shall obtain written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Contract Documents, and that the designated single manufacturer accepts the CONTRACTOR's assignment of responsibility for coordination of gate equipment, including operators, controls, and services required for proper installation and operation.

E. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

1.4 QUALITY ASSURANCE

A. Equipment Field Testing

1. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.
2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Startup Assistance

1. Service and testing assistance by the manufacturer's engineering representative for each gate and valve shall be available as needed by the CONTRACTOR during installation and startup.

B. Instruction of OWNER's Personnel

1. The CONTRACTOR shall arrange for the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment.



## 1.6 SPECIAL WARRANTY REQUIREMENT

- A. The CONTRACTOR shall furnish the manufacturer's written guarantee that the hydraulic gates comply with the indicated requirements.
- B. The CONTRACTOR shall furnish the manufacturer's warranties as published in its literature.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Equipment provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products and which have had previous experience in such manufacture.
- B. The CONTRACTOR shall, upon request, furnish the names of not less than 5 successful installations of the manufacturer's equipment of comparable nature to that offered under the Contract.
- C. Combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the CONTRACTOR and the manufacturer shall be responsible for the compatible and successful operation of the various components of the units.
- D. Indicated and necessary mountings and appurtenances shall be included.

### 2.2 MATERIALS

- A. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

### 2.3 HARDWARE

- A. Bolts and nuts shall comply with the requirements of Section 05 55 00 – Miscellaneous Metalwork.

### 2.4 PROTECTIVE COATING

- A. Coat ferrous metal in accordance with the requirements of Section 09 96 00 – Protective Coating

### 2.5 TOOLS AND SPARE PARTS

- A. Tools
  - 1. Furnish special tools that are necessary for maintenance and repair of the gates.

2. Such tools shall be suitably stored in metal toolboxes and identified with the equipment number by means of stainless steel or solid plastic nametags attached to the box.

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION**

- A. Slide and shear gates shall be installed in strict accordance with the manufacturer's printed recommendations and the indicated requirements.
- B. Operators shall be located as to avoid interference with handrails and structural members.
- C. Damage to surface coatings incurred during shipment or installation shall be repaired.

- END OF SECTION -

## **SECTION 43 30 58 - FLAP GATES**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide flap gates, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 35 20 15 – Hydraulic Gates, General, apply to this Section.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Complete description of all materials including the material thickness of all components
- C. Installation drawings showing all details of construction, details required for installation, dimensions and anchor bolt locations at least 30 days before flap gates installation.
- D. Maximum bending stress and deflection of the flap under the maximum design head (seating head).

#### **1.3 QUALITY ASSURANCE**

- A. All of the equipment specified under this Section shall be furnished by a single manufacturer.

### **PART 2 -- PRODUCTS**

#### **2.1 FLAP GATES**

- A. Design
  - 1. Flap gates and frames shall be of cast iron construction, with fully-adjustable top pivot points and bronze sealing surfaces.
  - 2. Gate frames shall be provided with flat backs for attachment to wall thimbles, unless otherwise indicated.
- B. Wall Thimbles
  - 1. Unless otherwise indicated, flap gates shall be mounted against cast iron wall thimbles with Type 316 stainless steel bolts, anchor bolts, nuts, and washers, and sealant or gaskets.
  - 2. The thimbles shall be of the F-pattern type, in order to match the thickness of the walls in which they are installed.
  - 3. Wall thimbles shall be furnished by the manufacturer of the gates, in order to match the bolt dimensions of the gates.

C. Sealant Manufacture, or Equal

1. The elastomeric sealant shall be **Rubber Caulk Sealer** as manufactured by **Products Research Company, Los Angeles**.

D. Grout

1. Gates mounted against concrete walls without wall thimbles shall be installed with one-inch-thick non-shrink grout between the wall and the gate flange.

E. Flap Gate Manufacturer or Equal

1. **Hydro Gate Corp., Model 20C** or **10C** for round openings
2. **Fresno Valves and Castings**
3. **Waterman**
4. **Rodney Hunt Company, Series FV-AC**

### **PART 3 -- EXECUTION**

#### **3.1 INSTALLATION**

- A. Flap gates shall be installed in strict accordance with the requirements of Section 43 30 56 – Hydraulic Gates, General.

- END OF SECTION -

## **SECTION 43 30 61 – CAST IRON SHEAR GATES**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide slide and shear gates, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 43 30 56 – Hydraulic Gates, General, apply to this Section.

#### **1.2 CONTRACTOR SUBMITTALS**

##### **A. Shop Drawings**

- 1. Submit the following:
  - a. Drawings of gates, frames, slides, and actuators
  - b. Design load calculations for deflection at the maximum expected head
  - c. Calculations for the lifting force generated by 40 pounds effort on the lever in order to operate the gate.

#### **1.3 QUALITY ASSURANCE**

- A. Leakage criteria for field test shall conform to AWWA Standards.

### **PART 2 -- PRODUCTS**

#### **2.1 SHEAR GATES**

##### **A. Construction**

- B. Shear gates shall be of cast iron construction with a bronze seat and disc rings, and a flanged frame equipped with a minimum handle length such that the handle is a minimum of 6-inches above the finished surface elevation.

##### **C. Coating**

- 1. Each gate, including accessories, shall be epoxy-coated in accordance with the requirements of Section 09 96 00 – Protective Coating.
- 2. Care shall be exercised in order to protect machined surfaces during sand blasting and coating.

- D. Mounting hardware, if indicated or required, shall be constructed of Type 316 stainless steel.

##### **E. Manufacturers, or Equal**

- 1. **Troy Valve, Model A-2520**

2. **Waterman, Model C-16**

**PART 3 -- EXECUTION**

3.1 **INSTALLATION**

- A. Sluice and shear gates shall be installed in strict accordance with the requirements of Section 43 30 56 – Hydraulic Gates, General.

- END OF SECTION -

## **SECTION 43 30 62 - SLIDE/STOP GATES**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide slide/stop gates, complete and operable, in accordance with the Contract Documents.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Shop Drawings
  - 1. Submit the following:
    - a. Drawings of gates, frames, slides, and actuators
    - b. Design load calculations for deflection at the maximum expected head
    - c. Calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.

#### **1.3 QUALITY ASSURANCE**

- A. The leakage allowance for slide gates under the design seating and unseating heads shall conform with the AWWA Standards.
- B. Factory Testing
  - 1. Gates shall be factory-assembled and functionality-tested prior to delivery to the Site.
  - 2. Test certificates shall be submitted.

### **PART 2 -- PRODUCTS**

#### **2.1 GENERAL**

- A. Gates shall comply with the following Standards:
  - 1. AWWA C513 (unless indicated otherwise) Open-Channel, Fabricated-Metal Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
  - 2. AWWA C561 Stainless Steel Slide Gates
  - 3. AWWA C562 Aluminum Slide Gates
  - 4. AWWA C563 Composite Slide Gates
- B. Gates shall be new and of current manufacture, adequately braced in order to prevent warpage and bending under the intended use.
- C. Gate actuators shall be sized, selected, and furnished by the gate manufacturer.

D. Gate actuators throughout the project shall be products of a single manufacturer.

E. Mounting Requirements

1. Guide frames shall be extended 3 feet, 6 inches above the walkway in order to match the height of the handrail.
2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.
3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

## 2.2 STAINLESS STEEL SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C561 suitable for the service.
2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Disc & Stiffeners	ASTM A276, Type 304 Stainless Steel
Yoke Support Beam	ASTM A36 Structural Steel or ASTM A276, Type 304 Stainless Steel
Frame & Guides	ASTM A276, Type 304 Stainless Steel
Stem and Coupling	ASTM A276, Type 304 Stainless Steel
Stem Guides (at base of Yoke or integral to pedestal style)	ASTM A276, Type 304 Stainless Steel with UHMW bushing
Stem Cover	Transparent plastic pipe with UV inhibitors, Sched. 40 minimum
Disc Seats	UHMW Polyethylene, ASTM D4020
Invert (Base) Seal	For flush bottom gates: Embed "Q-bottom" Neoprene / rubber seal by Waterman or type "Hy-Q" stepped seal. Embeds shall be ASTM A167, A 276, Type 304 Stainless Steel  For non-flush bottom gates: Frame Mounted Invert Seal, Neoprene / Rubber, ASTM D 2000, Grade AA625.



Side and Top Seals	"J-bulb" Type or Self-Adjusting Neoprene Cord Seals, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Metal Contact Surfaces for Seals (invert sill & J-side seals where used)	ASTM A167, A 276, Type 304 Stainless Steel
Fasteners (including studs, anchors, assembly bolts, nuts and hardware)	ASTM F593, F594, Type 316 Stainless Steel

- B. **Design Hydraulic Loading.** Each slide gate shall be designed for the hydraulic loading characteristics as defined by the maximum seating head and unseating head conditions as specified in the Gate Schedule on the Contract Drawings.
- C. **Gate Design.** All fabricated steel gate components shall have a minimum thickness of 1/4-inch unless specified otherwise.
1. **Slide Cover (Disc) and Stiffeners.** The gate slide cover (disc) shall consist of a flat plate reinforced with structural or formed members welded to the plate.
    - a. The disc is to be designed to limit deflection of the gate to 1/720 of its span or 1/16-inch at the sealing surface of the gate under maximum specified head.
    - b. The working design stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
  2. **Frame / Guides.** The gate frame shall consist of guides, invert member, and a fabricated operator yoke assembly. The guides shall be of a sandwiched type construction built up of plates, angles, and formed shapes. The guide slot shall engage the disc plate a minimum of 1-inch.
    - a. Disc and frame shall be designed to resist a hydraulic load of the gate being closed under maximum seating head conditions and also opening the gate under these conditions
    - b. The working stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
    - c. The disc and frame design shall be arranged such as to allow simple removal of the disc from the frame, when required for maintenance.
    - d. **For non-flush bottom gates to a concrete floor,** frames shall be furnished with a flush seal arrangement. A resilient seal with a minimum width of exposed face of 1.375" shall be securely attached to the frame along the invert, and shall extend to the depth of the guide groove. The resilient seal extrusion shall be constructed to be ribbed and self-retaining. For non-flush bottom gates, invert seal designs that require mechanical retention are not allowed.

- e. **For flush bottom gates to a concrete floor**, a stainless steel embed shall be grouted by the CONTRACTOR into a block-out of the concrete in the channel floor. Either of the following two design approaches are acceptable for the flush bottom seal:
  - 1) A 3-inch deep block-out shall be provided where the stainless steel embed shall retain the neoprene / rubber seal and prevent its dislodging during normal water flow operation over the gate invert. ("Q" bottom seal by Waterman), or
  - 2) A stainless steel L-bracket piece shall be cast or grouted into the floor to be flush with the floor invert. The neoprene step seal shall be fastened to the bottom of the gate structure and shall make a continuous seal with the stainless embed (stepped "HY-Q" flush seal by Rodney Hunt)
- 3. **Steel Yoke Support Beam.** Gate lifting and lowering shall be supported by a steel support framing system (yoke) designed and fabricated by the gate Manufacturer. The yoke shall be designed and fabricated according to the following:
  - a. Designed to span the open width (W) on the top deck as shown on the Contract Drawings.
  - b. Designed for the maximum output of the gate hoist.
  - c. Designed to transmit the full weight of the gate plus the hydraulic (friction) load created when the gate is closed and the seating heads are as defined above. The deflection not to exceed  $W/360$ , where W equals the width of the opening across which the Yoke is spanning.
  - d. Yoke shall be designed out of parallel C or box-channel members which shall not exceed 12-inches in height. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
  - e. Yoke shall be designed with an integral stem guide to be attached to the bottom of the yoke. Stem guide shall have bronze or UHMW or other approved bushing to guide the stainless steel stem.
- 4. **Seals.** Resilient seals shall be placed along the top, bottom, and both sides of the gate to prevent leakage. The seal attaching hardware shall be stainless steel and attached in a manner to permit replacement of the seals. The gate side and top seals may be of the "J-bulb" type style or may be designed as a self-adjusting neoprene cord seal as described below.
  - a. For the self-adjusting cord seal, the UHMW seats shall impinge on the slide (disc) by way of a continuous loop neoprene cord seal.
  - b. J-bulb seal corners shall be formed by continuous molded sections. Joints between the molded corners and top or side seals shall be a square butt type located a minimum of 12-inches from the corner. The molded corner shall be bonded to the top and side seal and assembled to the gate disc in the manufacturer's shop. Mitered joints shall not be used.

“J-bulb” type seals or self-adjusting neoprene cord seals shall be retained by the frame to restrict leakage to the following limits:

- c. Under a design seating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm/lineal foot of gate perimeter.
  - d. Under a design unseating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm/lineal foot of gate perimeter.
5. **Guide Slots, Sill, and Yoke.** Prefabricated guide slots, sill, and yoke shall be provided as follows:
- a. Guides shall be extended to support no less than 1.66 times the height of the slide in the open position (as measured from the invert of the gate opening). For self-contained gates the frame shall extend at least 36 inches above the operating platform or as shown in the contract drawings. The yoke shall be designed to support the thrust of the actuator with a minimum safety factor of 4 in regard to the ultimate tensile, compressive and shear strengths of the materials. *(Manufacturer is referred to section 4.4.5.1 of AWWA C561-12)*
6. **Stems.** Stems shall be of solid construction, of the **rising-stem** type with threads of the cut Acme type. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 pounds effort on the crank or handwheel.
- a. The L/r ratio of the unsupported stem shall not exceed 200.
  - b. Stem guides, where required to limit the unsupported stem length, shall be UHMW or bronze bushed.
  - c. All gates having widths greater than two times their height shall be provided with two lifting devices connected by a tandem shaft for simultaneous operation.
7. **Stem Covers.** Rising stem gates shall be provided with clear stem covers to provide indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. Vent holes shall be provided to prevent condensation.

**D. Anchor / Mounting Bolts**

- 1. The diameter, length, quantity and location of the slide gate anchor hardware shall be determined by the slide gate Manufacturer and clearly shown in installation literature.
- 2. All anchor hardware including studs, adhesive anchor bolts, other bolts, nuts and washers shall be provided by the gate Manufacturer to the CONTRACTOR for installation. Use of expanding style wedge mechanical anchors shall not be allowed.

**E. Wall Thimbles**

1. F-style wall thimbles shall not be required of the new fabricated slide gates to be furnished. Rather, gate frames shall be mounted to the concrete walls using 316 stainless steel epoxy adhesive anchor bolts per Part 2.2.D above.

**F. Lifting Device / Gate Manual Actuator**

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.
3. Pedestal Mounting
  - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
  - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 3.5 feet above the floor for frame-mounted actuators.
5. Slide gate hoist heads shall be constructed of cast iron.
6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
7. Operating thrust shall be taken on roller or ball bearings.
8. Parts shall be provided with an alternative lubrication system.
9. Hand Wheel Operator
  - a. The unit shall be designed for a 40–pound maximum effort on the wheel/crank in order to operate the gate.
  - b. Clockwise movement of the handwheel shall close the gate.
  - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

**G. Welding**

1. All welding shall be performed in accordance with AWS D1.1. All welders shall be certified with current AWS welder certifications.

**H. Coatings**

1. Any exposed ferrous surfaces (non stainless steel components) shall be blasted to SSPC SP-10 and receive coating system No. 51 (Polyamide epoxy), prior to their

assembly. The polyamide epoxy coating system shall meet the following requirements:

- a. Product shall be a high-build polyamide cure epoxy with a maximum VOC content of 366 g/L. Product shall be suitable for long-term immersion in water and resistant to corrosion.
  - b. Product shall be applied in a minimum of two coats and shall have a total dry film thickness (DFT) of no less than 12 mils.
  - c. Acceptable product manufacturers include Ameron Amercoat 370, or Tnemec Pota Pox Series 20 or Carboline Carboguard 61.
2. Components not requiring painting, (e.g., non-metallic seating surfaces and all 316 stainless steel surfaces) shall be protected from overspray during the ferrous surface coating process.

**I. Gate Manufacturers, or Equal**

1. **Waterman Industries SS-251-1**
2. **Whipps Model 925**

**2.3 ALUMINUM SLIDE GATES**

**A. Construction**

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C562 suitable for the service.
2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Aluminum Gates	
Slide	Aluminum, ASTM B 209 Alloy 6061-T6
Frame	Aluminum ASTM B 308 Alloy 6061-T6
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Aluminum pipe with slots and indicator
Guides and seats	UHMW Polyethylene, ASTM D 4020

Seals	"J" bulb Type, Neoprene, ASTM D 2000. Flat seals are not acceptable
Stainless Steel Gates	
Slide	ASTM A 276, Type 316, or Type 316 L
Frame	ASTM A 276, Type 316, or Type 316 L
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Aluminum pipe with slots and indicator
Guides and seats	UHMW Polyethylene, ASTM D 4020
Seals	"J" bulb Type, Neoprene, ASTM D 2000. Flat seals are not acceptable.

#### B. Lifting Devices

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.
3. Pedestal Mounting
  - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
  - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 4 feet above the floor for frame-mounted actuators.
5. Power lifting devices shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
6. Slide gate hoist heads shall be constructed of cast iron.
7. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
8. Operating thrust shall be taken on roller or ball bearings.

9. Parts shall be provided with an alternative lubrication system.
10. Handwheel Crank
  - a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
  - b. Clockwise movement of the handwheel shall close the gate.
  - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

C. Manufacturers, or Equal

1. **Rodney Hunt Company**
2. **Hydro Gate Corp.**
3. **Washington Aluminum Company, Inc. (WACO)**
4. **Waterman Gate Company**

## 2.4 CAST IRON SLUICE GATES (AWWA C560)

- A. **General:** Each gate shall be a heavy duty sluice gate and furnished and installed complete with wall thimble or anchor bolts as indicated in the above schedule. All gates shall be furnished with operating stem, manual operator and other appurtenances as specified or needed to make a complete and operable installation. All component parts shall be of the type of material specified and interchangeable where size and material are the same without grinding, chipping or special fitting in the field. The gate shall be the product of one manufacturer having five or more years of experience in the manufacture of similar gate for similar use. All mating and sliding parts shall be fully machined.
- B. **Materials:** Materials of construction for each gate and mounting assembly shall be as follows:

Description	Materials Standards
<b>Mounting Assembly</b>	
Anchor Bolts and Nuts	Stainless Steel Type 18-8, ASTM F593, F594
Stem Cover	Aluminum, with slots and indicator
Wall thimble	Cast Iron, ASTM A126 Class B, or A 48, Class 30
<b>Gate Assembly</b>	

Frame, Slide, and Guide Rails	Cast Iron, ASTM A126 Class B
Seating Faces and Stem Guide Bushings	Naval Bronze, Alloy 482, ASTM B-21
Wedges	Manganese Bronze Alloy 865, ASTM B-584
Fasteners	Stainless Steel Type 18-8, ASTM F593, F594
Stem Blocks	Manganese Bronze Alloy 865, ASTM B-584
<b>Self-Contained Type</b>	
Yoke	Fabricated A-36 Steel or Stainless Steel Type 316, ASTM A 276. (If A-36 carbon steel is used, yoke shall be coated with liquid epoxy system, 2 coats with total minimum DFT = 20 mils.)
Stem	Stainless Steel Type 316, ASTM A 276

- C. **Frame and Guide Rails.** Frame and guide rails shall be cast one-piece construction or may have guides doweled and bolted to the frame. Guide rails shall be of such length as to retain at least one-half of the vertical height of the slide when it is in the fully opened position. A groove running the full length of the guide rail shall be accurately machined to receive the slide tongue, with a nominal clearance of 1/16-inch.
- D. **Gate Leaf (Slide).** The gate leaf shall be of one piece cast construction with vertical and horizontal ribs.
- E. **Seating Faces.** All seating faces for both gate leaf and frame shall be malleable extruded Naval Bronze of a shape that will fill and permanently lock in the full width dovetail grooves of the leaf and the frame. Seating faces shall be machined to a 63 micro-inch finish, or better.
- F. **Stems and Stem Couplings.** Operating stems shall be of a size to safely withstand, without buckling or permanent distortion, stresses induced by normal operating forces. Minimum stem size for sluice gate shall be 2 inches. Stems shall be fabricated from round bar stock of stainless steel or bronze, as shown on the plans or gate schedule and shall be provided with 29° modified or full acme threads. Stems composed of two or more sections shall be joined by bronze couplings threaded and keyed to stems, or couplings of the same material as the stems, pinned, bolted or welded and pinned to the stems. In section, couplings shall be stronger than the stems.
- G. **Stem Guides.** Stem guides shall be cast iron, with bronze bushings, and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they will hold the stem in alignment and still allow enough play to permit easy operation. Stem guide spacing shall be as shown, but in no case shall it exceed an l/r ratio of 150. Brackets shall be attached to the wall by anchor bolts and sufficient strength to prevent twisting or sagging under load.



- I. **Operator Pedestal.** Operator pedestal shall be a fabricated A-36/A-53 steel mounted directly to the yoke.
- J. **Stem Covers.** Rising stem gate shall be provided with slotted aluminum stem covers to facilitate indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. The cover shall be marked with graduations in feet with minor graduation in 0.01 feet. The graduations shall be installed to match 0.00 when the gate is seated closed. Vent holes shall be provided to prevent condensation.
- K. **Mounting Requirements**
  - 1. For outdoor applications, guide frames shall be extended 3.5-ft above the walkway in order to match the height of the handrail.
  - 2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.
  - 3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.
- L. **Lifting Devices**
  - 1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
  - 2. The lifting devices shall be weatherproof.
  - 3. Pedestal Mounting
    - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
    - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
  - 4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 4 feet above the floor for frame-mounted actuators.
  - 5. Power lifting devices shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
  - 6. Slide gate hoist heads shall be constructed of cast iron.
  - 7. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
  - 8. Operating thrust shall be taken on roller or ball bearings.

9. Parts shall be provided with an alternative lubrication system.

10. Handwheel Crank

- a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
- b. Clockwise movement of the handwheel shall close the gate.
- c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

M. **Wall Thimbles.** Wall thimble shall be provided with the gate where indicated in the gate schedule. Thimble shall be of one-piece cast iron construction and of the section and depth as specified in the plans and gate schedule. There shall be an integrally cast water stop around the periphery of the thimble.

1. The front flange of the thimble shall be machined, drilled and tapped to receive the sluice gate attaching studs. Bolt pattern shall match gate bolt pattern.
2. Unless otherwise indicated, sluice gates shall be provided with cast iron, F-pattern wall thimbles to match the thickness of the walls in which they are installed.
3. Thimbles shall be furnished by the manufacturer of the gates and shall fit the bolt dimensions of the gates.
4. Studs shall be constructed of Type 316 stainless steel.
5. If wall thimbles are utilized, elastomeric sealant shall be provided and shall be **Rubber Caulk Sealer** as manufactured by the **Product Research Company**, or equal.
6. Inside water way passage of cast iron wall thimbles shall be lined with liquid epoxy per AWWA C210

N. **Manufacturers, or Equal**

1. **Golden Harvest**
2. **Waterman Industries**
3. **Fresno Valves and Castings**

## 2.5 ALUMINUM STOP GATES

A. Construction

1. Wall-mounted, hand-lift stop gates with handles shall be fabricated of 1/4-inch aluminum as indicated, and shall be reinforced as necessary in order to assure long life under the indicated operating conditions, in accordance with AWWA C562.
2. Gates shall be provided with “J” bulb type neoprene seals.

3. Calculations and detail drawings, as necessary, shall show the method of fabrication and shall verify that the plates will withstand any normal pressures or forces exerted, without buckling or otherwise being damaged.
4. Mounting hardware, if indicated or required, shall be constructed of Type 316 stainless steel.

B. Manufacturers, or Equal

1. **F.B. Leopold Co. (Division of Sybron Corp.)**
2. **Washington Aluminum Co., Inc.**
3. **Waterman Gate Company**

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## SECTION 44 35 00 - PUMPS, GENERAL

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. Provide pumps and pumping appurtenances, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.
- C. The requirements of Section 43 00 00 – Equipment General Provisions, apply to this Section.
- D. **Responsibilities**
  - 1. The pump manufacturer shall be made responsible for furnishing the WORK and for the coordination of design, assembly, testing, and installation of the WORK of each specific pump Section.
  - 2. The CONTRACTOR shall be responsible to the OWNER for overall compliance with the requirements of each specific pump Section.
- E. **Single Manufacturer**
  - 1. Where two or more pump systems of the same type / style are required, pumps shall be provided by only one (1) manufacturer and shall be of the same model type.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings.** At a minimum, submit the following information:
  - 1. Submit pump name, identification number, and specification Section number.
  - 2. Performance Information
    - a. Submit performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.
    - b. Require the equipment manufacturer to 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.
  - 3. Operating Range
    - a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.

- b. Provide a stable operating range as wide as possible, based on actual hydraulic and mechanical tests.
4. Submit assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
5. For the electric motor proposed for each pump, submit data in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.
6. Submit interior and front-panel elevations of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of all terminals required to receive inputs or to transmit outputs from the local control panel.
7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.
8. Submit a complete electrical schematic diagram.

**C. Technical (O & M) Manual**

1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

**D. Spare Parts List**

1. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

**PART 2 -- PRODUCTS**

**2.1 GENERAL**

- A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

**B. Pump Performance Curves**

1. Provide centrifugal pumps with a continuously rising curve or with the system operating range not crossing the pump curve at two different flow capacities or “dip region.”
2. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine and shall not encroach on the motor service factor.

**C. Compatibility**

1. Provide entirely compatible components of each pump system provided under the specific pump Section.

2. In each unit of pumping equipment, incorporate basic mechanisms, couplings, electric motors or engine drives, necessary mountings, and appurtenances.

## 2.2 MATERIALS

- A. Provide materials suitable for the intended application.
- B. Pump materials shall be as indicated below, unless specified otherwise in the specific pump sections. Pump materials shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:
  1. Casing and Bowls. Provide cast iron pump casings and bowls constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.
  2. Impellers. Provide bronze pump impellers conforming to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications, where dezincification does not occur.
  3. Shafts. Provide pump shafts constructed of Type 416 or Type 316 stainless steel.
  4. Miscellaneous stainless steel parts shall be of Type 316.
- C. Materials in contact with potable water or fisheries supply water shall be listed as compliant with NSF Standard 61.

## 2.3 PUMP COMPONENTS - GENERAL

### A. **Flanges and Bolts**

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions, unless noted otherwise in the specifications.
2. Flange bolts and hardware shall be in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

## 2.4 PUMP MOTORS

- A. Unless noted otherwise, furnish all pump motors in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.

## 2.5 PUMP APPURTENANCES

### A. **Nameplates**

1. Equip each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. **Pressure Gauges.** Provide pressure gauge assemblies as indicated on the Process Schematic Drawings or Process and Instrumentation Drawings (P&IDs), as follows:

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauge assemblies installed at the pump discharge lines.
2. Provide pump suction lines with compound gauges, where indicated on the process schematics.
3. Locate gauges in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Where subject to shock or vibrations, wall-mount the gauges or attach the gauges to galvanized channel floor stands and connect by means of flexible connectors
4. Where subject to freezing temperatures, provide gauges with glycol liquid fill fluid, and CONTRACTOR shall minimize the  $\frac{3}{4}$ " or 1" connecting pipe nipple length to the
5. Factory Non-witnessed Test
  - a. Test centrifugal pump systems with drives 10 hp up to and including 125 hp at the pump factory in accordance with the *ANSI / HI Rotodynamic Pumps for Hydraulic Performance Acceptance Tests – 2011*, per Table 14.6.3.4) acceptance Grade "1B" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute.
  - b. For sump pumps, sample pumps, and smaller pumps of motor size from 0.75 to 10 HP, acceptance grade shall be in accordance with Grade "2B" of *ANSI / HI Rotodynamic Pumps for Hydraulic Performance Acceptance Tests – 2011*, per Table 14.6.3.4, unless otherwise specified.
  - c. Perform tests using the complete pump system to be furnished, including the Project motor and variable speed drive if equipped with variable speed drive.
  - d. For pumps with motors of 100 HP or smaller, the manufacturer's certified test motor will be acceptable for use during factory testing.
  - e. Testing of prototype pump models will not be accepted.
  - f. Conduct the following minimum tests and submit the test results:
    - 1) Hydrostatic test;
    - 2) Performance Test:
      - a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute standards;
      - b) Submit pump curves showing head, flow, bhp, and efficiency results;



- 3) Mechanical test;
- 4) NPSH
  - a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.
  - b) If not required by the specific pump Section, submit the published manufacturer-calculated NPSHr3 curve.
- g. Submit certification signed by a senior official of the pump manufacturer that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.
- h. Submit test results to the ENGINEER for review prior to delivery to the Site.
- 6. Acceptance
  - a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

## **PART 3 -- EXECUTION**

### **3.1 INSTALLATION**

#### **A. General**

- 1. Install pumping equipment in accordance with the manufacturer's written recommendations.

#### **B. Alignment**

- 1. Field-test the equipment in order to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects.
- 2. Measure the pump drive shafts just prior to assembly in order to ensure correct alignment without forcing.
- 3. Ensure that the equipment is secure in position and neat in appearance.

#### **C. Lubricants**

- 1. Provide the necessary oil and grease for initial operation.

### **3.2 PROTECTIVE COATING**

- A. Coat materials and equipment in accordance with the requirements of Section 09 96 00 – Protective Coatings, unless otherwise specified in the specific pump section.

### 3.3 FIELD TESTS

- A. Field-test each pump system after installation in order to demonstrate:
  - 1. Satisfactory operation without excessive noise and vibration;
  - 2. No material loss caused by cavitation;
  - 3. No overheating of bearings; and,
- B. Conduct the following field testing:
  - 1. Startup, check, and operate the pump system over its entire speed range.
  - 2. If the pump is driven at constant speed, test the pump and motor at the maximum RPM.
  - 3. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the ENGINEER.
  - 4. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed.
    - a. Perform tests at maximum RPM if equipped with a constant speed drive.
  - 5. Check each power lead to the motor for proper current balance.
  - 6. Bearing Temperatures
    - a. Determine bearing temperatures by a contact-type thermometer.
    - b. Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.
  - 7. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.
- C. Witnessing
  - 1. Field testing will be witnessed by the ENGINEER.
  - 2. Furnish the OWNER and ENGINEER with at least 7-Days advance notice of field testing.
- D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.
- E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.
  2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.
- F. The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.
- G. If available, the OWNER'S operating personnel will provide assistance in field testing.

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## **SECTION 44 35 04 - PACKAGED BOOSTER PUMP SYSTEM**

### **PART 1 -- GENERAL**

#### **1.1 DESCRIPTION OF WORK**

- A. Work includes furnishing all labor, material, and equipment required to supply, install, and test process water handling pumps, drive units, controls, and appurtenances to pumping equipment as specified herein and required to make the units complete and fully operable.

#### **1.2 SUBMITTALS**

- A. Submit product data and shop drawings in accordance with Section 01 33 00 and operating and maintenance instructions
- B. Submit manufacturer's product data on pump and driver. Submittals shall include the following features:
  - 1. Manufacturer's specifications data and descriptive literature.
  - 2. Factory certified performance curves showing capacity in gpm, NPSH, head, efficiency and pump horsepower from 0 gpm to 110% of design capacity.
  - 3. Motor efficiency and power factor at all design operating points.
  - 4. Drawings showing general dimension, confirming the size of the pump, openings, connections, construction details of the equipment, wiring diagrams, piping drawings, and weights of major components.
  - 5. Procedures for proper installation.
  - 6. Manufacturer's guarantee.
  - 7. Information about the nature and location of parts, service crews, and repair facilities.

#### **1.3 OPERATION AND MAINTENANCE DATA**

- A. Operating and adjustment instructions.
- B. Parts lists.
- C. Disassembly, repair, and assembly instruction including drawings.
- D. Maintenance procedures and recommended maintenance intervals.

## PART 2 -- PRODUCTS

### 2.1 UTILITY WATER PUMP

- A. The utility water pump shall be a packaged booster pump system consisting of a pump, hydropneumatic tank(s) and controls to automatically start and stop the pump.
- B. System operation: Upon water demand, water will flow from the pressure tank to the system. This will cause the pressure to drop as sensed by a pressure switch. Upon drop in pressure, the pump will start and run continuously until the water in the volute of the pump heats up (indicating a dead head condition) and trips a temperature switch.
- C. System components shall include: Pressure tank, pressure and temperature switch, suction check valve, pressure and temperature relief valve, completely wired motor control and a steel base.
- D. Pump shall be a bronze fitted, end suction centrifugal pump, with mechanical seal. Pump volute shall be constructed of cast iron and shall be fitted with bronze wear rings.
- E. **Drive Motor:** Pump motor shall be in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.
- F. **Control:** Muster all control and power wiring to one or two control enclosures located on the skid, located on the accessible side of the skid and mounted such that control pilot devices are not installed below 48" above finished floor, including house-keeping pads. Control enclosure(s) shall contain all required motor starting and control components for a complete and operable system. The control panel and all related control components shall be provided in accordance with the requirements of Sections 40 90 18 – Vendor Package Control Systems and 40 90 05 – Control Enclosures and Devices.
- G. Pump shall be Paco model 848A or Tiger Flow System Bengal Duplex Vertical Booster System or equivalent.
- H. Suction strainer shall be provided to prevent debris up to 1" diameter from entering pump and utility water system.
- I. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-380	Coho Building	50	116	480/3/60	3
P-580	Chinook Building	50	116	480/3/60	3

P-680	Spawning Building	50	116	480/3/60	3
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### 3.1 PRESSURE TANK

- A. Two hydropneumatic pressure tanks with a tank capacity of 80 gallons shall be provided in series with the discharge of each booster pump utility water line. Each tank shall be equipped with an isolation valve, pressure relief valve, pressure gauge, blowdown port, and all ancillary protective devices as per the 2019 California Plumbing Code.
- B. Pressure Tank shall be manufactured in accordance with ASME Section VIII and use an ASME Section VIII approved relief valve.

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. All equipment shall be installed in accordance with the manufacturer's recommendations. Alignment and adjusting shall be verified after installation.
- B. The pumps shall have an electrical disconnect complying with the NEC.

### 3.2 TESTING

- A. In addition to testing that may be required by codes, the CONTRACTOR shall perform all tests specified in this section and shall furnish and pay for all material and labor required for tests. Prior to start-up, the pump shall be tested in place. These tests shall duplicate all normal operating modes. Should tests indicate unsatisfactory operation, conditions shall be corrected, and the test repeated at the CONTRACTOR's expense.

## PART 4 -- WARRANTY

### 4.1 GENERAL

- A. The pumps shall be warranted for labor, equipment and all components for a one (1) year period after final acceptance.

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## SECTION 44 35 35 - HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide horizontal process end suction pumps and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 44 35 00 - Pumps, General apply to this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL DESCRIPTION:

- A. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-200	Intake Structure	20	60	480/3/60	2
P-201	Intake Structure	20	60	480/3/60	2
P-650	Adult Holding Pond	120	15	480/3/60	2

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Ambient environment	Outdoors
Fluid service	Raw Water
Fluid temperature, degrees F	40 to 80
Fluid specific gravity	1.0

Project site elevation, ft (m.s.l)	2,500
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## 2.2 PUMP REQUIREMENTS

- A. **Construction:** Construction of horizontal ANSI end-suction pumps shall conform to the following requirements:

Casing, foot-mounted	Cast iron, ASTM A 48 back pullout design with gauge connections
Pump base	Cast iron base plate with drain rim or pan
Impeller	Ductile iron ASTM A395 or A536 statically and dynamically balanced, open
Shaft	Type 416 Stainless Steel designed for max 0.002 inch deflection at sealing face at max load
Seal	Mechanical Seal
Coupling	Flexible heavy duty spacer shaft coupling with guard
Mounting	Frame mounted
Lubrication	Grease with inlet and drain fittings

- B. **Drive:** Direct drive with flexible coupling with heavy duty, horizontal, electric motor suitable for 480 volt, 3-phase, 60-Hz power supply, in accordance with Section 26 05 10 - Electric Motors.

## 2.3 PUMP CONTROLS

- A. Pumps shall be controlled in accordance with Section 40 90 00 - Process Control and Instrumentation Systems.

## 2.4 SPARE PARTS

- A. Furnish the following spare parts for each pump:

1. One mechanical seal
2. One set of all bearings
3. One shaft sleeve
4. Two sets of all washers, seals, and O-rings

## 2.5 MANUFACTURERS OR EQUAL

- A. **Goulds Pumps, Inc.**
- B. **Peerless Pump Company.**
- C. **Worthington (Ingersoll-Dresser Pump Company)**
- D. **Flint & Walling**

## **PART 3 -- EXECUTION**

### 3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.
- B. General installation requirements shall be in accordance with Section 44 35 00 - Pumps, General.

- END OF SECTION -

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## SECTION 44 35 54 – RACEWAY VACUUM PUMP

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide a portable vacuum pump cleaning system, complete and operable, in accordance with the Contract Documents.
- B. The vacuum pump cleaning system includes a cart-mounted self-priming diaphragm pump with suction and discharge hoses and vacuum cleaning head attachment.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings.** At a minimum, submit the following information:
  - 1. Submit pump name, identification number, and specification Section number.
  - 2. Performance Information
    - a. Submit performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.
    - b. Require the equipment manufacturer to 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.
  - 3. Operating Range
    - a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.
  - 4. Submit assembly drawings including part nomenclature, material list, outline dimensions, and shipping weights.
- C. **Technical (O & M) Manual**
  - 1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

### PART 2 -- PRODUCTS

#### 2.1 DIAPHRAGM PUMP

- A. Identification

Equipment Number	P-100, P101
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Quantity	2
Location	Coho Building; Chinook Incubation Building

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Fluid service	Raw Water, Sludge
Fluid temperature, degrees F	50 to 70
Fluid pH range	6.5 to 7.5
Fluid specific gravity	1.0
Project site elevation, ft asl	2503.0
Minimum available NPSH, ft absolute	25.0

- C. Performance Requirements

Design flow capacity, gpm	50
Design flow pump head TDH, ft	12
Maximum sphere to pass, in dia	1.625
Maximum pump speed, rpm	1725

- D. Pump Dimensions

Suction ID, in	3
Discharge ID, in	3

- E. Pump Construction

1. **General:** The pump shall be of the single diaphragm type and conform to the following requirements:

Pump base	Cart-Mounted
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Pump casing	Cast iron, Cast Aluminum
Pump cover, flanged	Cast iron, Cast Aluminum
Diaphragm	Thermoplastic Santoprene, Neoprene
Check valves	Swing checks
Drive	Electric heavy-duty 1725 rpm TEFC motor, 1.5 hp, 208 volt, 1-phase, 60 Hz, cart-mounted
Power Cord	SJOW power cord, maximum 50 ft, with 12/3 AWG conductors. Provide with watertight, twist-lock 6-20P plug connector.

F. MANUFACTURERS, OR EQUAL

1. **AMT Self Priming Diaphragm Pump, Model 337E-96**

2.2 ACCESSORIES

A. Supply Hose

1. **General:** The supply hose shall attach the vacuum pump to the 1 ½" vacuum head swivel port and conform to the following requirements:

Quantity	2
Material	Flexible PVC, EPDM Rubber, Low Density Polyethylene
Diameter (in)	3
Length (ft)	25
Inlet Connection Style	3" NPT
Outlet Connection Style	3" NPT x 1 ½" Socket Reduction

B. Discharge Hose

1. **General:** The discharge hose shall attach the vacuum pump to the waste drain cleaning station 2" cam lock quick disconnect and conform to the following requirements:

Quantity	2
Material	Flexible PVC, EPDM Rubber, Low Density Polyethylene

Diameter (in)	3
Length (ft)	15
Inlet Connection Style	3" NPT
Outlet Connection Style	3" NPT x 2" Cam Lock Plug Reduction

C. Vacuum Head

1. **General:** The vacuum head shall attach to the suction hose and conform to the following requirements:

Quantity	2
Body	Polyethylene with lead weights
Wheels	Adjustable height w/ roller bearings
Width (in.)	22

2. MANUFACTURERS, OR EQUAL

- a. Pentair Model VAC22

D. Extension Pole

1. **General:** The extension pole shall attach securely to the vacuum head and conform to the following requirements:

Quantity	2
Body	PVC
Length	Adjustable 2-ft to 10-ft

2. MANUFACTURERS, OR EQUAL

- a. Pentair Model BH10

## PART 3 -- EXECUTION

### 3.1 DELIVERY/STORAGE

- A. CONTRACTOR shall deliver the units to the site and shall protect and store the units until project completion.



### 3.2 TESTING

- A. CONTRACTOR shall test the units per the manufacturers recommended operation procedures. CONTRACTOR shall provide training on the operation of the units to the OWNER's operations staff.

- END OF SECTION -

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## SECTION 44 35 56 - SUBMERSIBLE SUMP PUMPS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide submersible sump pumps and appurtenant work, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 - Equipment General Provisions apply to the WORK of this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

### PART 2 -- PRODUCTS

#### 2.1 SUMP PUMPS

##### A. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-280	Metering Vault	79	20	120/1/60	1/2
P-660	Settling Pond	150	20	480/3/60	2
P-661	Settling Pond	150	20	480/3/60	2

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Ambient environment	Outdoors - Submerged
Fluid service	Waste Water
Fluid temperature, degrees F	40 to 80
Fluid specific gravity	1.0

Project site elevation, ft. a.s.l	2,500
Maximum size of spheres to pass, in. dia	0.5 in.

## 2.2 METERING VAULT SUMP PUMP; P-280

- A. The Contractor shall provide factory-tested pump, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment.
- B. Submersible Sump Pump shall be capable of handling 79 gpm at 20 feet head. The motor shall be rated at 1/2 HP, 120 volts, single phase, 60 Hz, and shall be hermetically sealed, permanent split capacitor type. Motor shall be protected with integral, automatically-resetting thermal overload. Unit shall come with a UL listed, 20' minimum, 3-wire SJOW cord and molded 20A grounding plug. Discharge shall be 2". Pump body and impeller shall be cast iron with the impeller being two vaned with pressure vanes on the side. Pump shall have support legs to maintain 3-1/2" clearance between pump suction and bottom of sump basin. Pump shall be UL listed. Pump shall be Zoeller Model N161, or approved equal.
- C. Controls shall be field adjustable and shall consist of three direct acting, momentary contact float switches with control panel. Float switches shall be start, stop, and high water alarm, and shall be mounted on the 2" discharge piping. Each switch shall have a 20 ft cable minimum.
- D. The control panel shall be provided in a NEMA 4X enclosure, containing a circuit breaker sized for the application, a magnetic motor contactor, pump run indicating light, and a hand-off-auto selector switch. An externally-mounted alarm light, alarm horn, and horn silence shall be provided on the control panel. The control panel shall have a dry auxiliary contact for high water alarm for remote signal. All the signaling indications and controls shall be mounted inside the enclosure. The outer door, strictly a security door intended to guard against vandalism, shall be padlockable. Control panel shall be Zoeller Model 10-1038 or approved equal.
- E. Replacement Parts: The Contractor shall provide one manufacturer's supplied repair kit including the following components: Seal, "O" ring, Gasket, Spacer, and Grommet.

## 2.3 SETTLING POND SUMP PUMP; P-680, P-681

- A. The Contractor shall provide factory-tested pump, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment.
- B. Submersible Sump Pump shall be capable of handling 150 gpm at 20 feet head. The motor shall be rated at 2 HP, 480 volts, three phase, 60 Hz, and shall be hermetically sealed. Motor shall be protected with integral thermal winding contact and seal leak sensing. Pump shall be provided with 120V motor protection relay for remote mounting and shall be Flygt MiniCAS II, or approved equal. Unit shall come with a 15' minimum SOOW cord. Discharge shall be 2 1/2". Pump body and impeller shall be cast iron with the impeller being two vaned with pressure vanes on the side. Pump shall have support

legs to maintain 3-1/2" clearance between pump suction and bottom of sump basin.  
Pump shall be Flygt Model 3068, or approved equal.

- C. Controls shall be field adjustable and shall consist of four direct acting, momentary contact float switches. Float switches shall be pump stop, lead pump start, lag pump start, and high water alarm. Each switch shall have a 20 ft cable. Float switches shall be Flygt Model ENM-10 or approved equal.
- D. The settling pond control panel shall be provided as shown on the Contract Drawings, with components as specified under Division 40.
- E. Replacement Parts: The Contractor shall provide one manufacturer's supplied repair kit including the following components: Seal, "O" ring, Gasket, Spacer, and Grommet.

## 2.4 CORROSION PROTECTION

- A. All consoles, panels, enclosures, and other equipment containing electrical or instrument and control devices shall be protected from internal corrosion through the use of corrosion-inhibiting vapor capsules.
- B. During construction period, periodically replace the capsules in accordance with the capsule manufacturer's recommendation.
- C. Replace all capsules just prior to final acceptance.
- D. Corrosion-Inhibiting Capsule Manufacturers:
  - 1. Northern Instruments: Model Zerust VC.
  - 2. Hoffmann Engineering: Model A-HCL

## PART 3 -- EXECUTION

### 3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.
- B. General installation requirements shall be in accordance with Section 44 35 00 - Pumps, General.

### 3.2 TESTING

- A. The Contractor shall set the sump pump start, stop, and alarm levels, at the direction of the Engineer. The Contractor shall test the operation of the sump pump by filling the sump with water and verifying the start and stop water levels no less than three full cycles, to the satisfaction of the Engineer.

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