

## SECTION 01120

### INSTALLATION, TESTING, AND COMMISSIONING FOR MBR EQUIPMENT

#### PART 1 – GENERAL

##### 1.01 GENERAL

- A. The Spirac Screen-Washer/Compactor equipment to be installed at the Tulalip WRP was purchased by the Owner. The SCREEN-WASHER/COMPACTOR Equipment manufacturer is Spirac
- B. The purchase documents for the SCREEN-WASHER/COMPACTOR Equipment specify the terms and conditions, including equipment requirements and the Technical Specifications.
- C. The SCREEN-WASHER/COMPACTOR equipment will to be provided by the Owner to the Contractor. It is the Contractor's responsibility to ensure that a complete and fully functional installation, in accordance with the Contract Documents, is provided. By submitting a bid, the Contractor has represented that he has reviewed the SCREEN-WASHER/COMPACTOR Documents and preliminary shop drawings for the equipment.
- D. By submitting a bid, the Contractor agrees to accept of the SCREEN-WASHER/COMPACTOR. Costs for all work necessary to install, test, and commission the SCREEN-WASHER/COMPACTOR shall be included in the bid item for the installation of the Screen-Washer/Compactor.
- E. Where the Contract Documents identify or differentiate between the scope of supply for the SCREEN-WASHER/COMPACTOR Equipment Supplier and the Contractor, such identification is made for the convenience of the Contractor, and is not necessarily complete or accurate. It is the Contractor's responsibility to provide all materials for a fully functional WRP that conforms to the Contract Documents, whether or not those materials are supplied by the SCREEN-WASHER/COMPACTOR Equipment Supplier, other Suppliers, or directly by the Contractor. The Owner will not be responsible for clarifying the SCREEN-WASHER/COMPACTOR Equipment Supplier's scope of supply or resolving disputes between the Contractor and the SCREEN-WASHER/COMPACTOR Equipment Supplier.
- F. Contractor shall be responsible for taking delivery (offloading) the SCREEN-WASHER/COMPACTOR Equipment when it is delivered to the site. Contractor is responsible for storage of SCREEN-WASHER/COMPACTOR Equipment after delivery to the site. Per Spirac requirements, all electrical, mechanical, and miscellaneous equipment and parts shall be stored in a dry enclosed heated (minimum 35 degrees Fahrenheit) space.

##### 1.02 SHOP DRAWINGS

- A. Preliminary shop drawings for the SCREEN-WASHER/COMPACTOR equipment have been submitted by the manufacturer and reviewed by the Owner. Portions of the

preliminary shop drawings pertaining to the SCREEN-WASHER/COMPACTOR installation are provided at the back of the bid package.

- B. The shop drawing information provided in the SCREEN-WASHER/COMPACTOR Supply Contract Documents includes the SCREEN-WASHER/COMPACTOR Equipment Supplier's scope of supply, equipment list, warranty information, and Spirac's scope exclusions. Shop drawing information is provided for the Screen-washer/compactor control system. Information on valves and instruments to be provided by the SCREEN-WASHER/COMPACTOR Equipment Supplier is not included in the Project Manual but may be available in electronic format to any plan holder who requests it. Available drawings from Spirac, showing their process and instrumentation diagrams, the necessary electrical connections, and the mechanical installation of the equipment, are included with the project Drawings. The complete Spirac SCREEN-WASHER/COMPACTOR equipment may not be available until the week of October 24, 2016.

## **PART 2 – PRODUCTS**

### **2.01 EQUIPMENT SUPPLIED BY SCREEN-WASHER/COMPACTOR EQUIPMENT SUPPLIER**

- A. The SCREEN-WASHER/COMPACTOR Equipment Supply Documents and the preliminary shop drawings describe the scope of supply of the SCREEN-WASHER/COMPACTOR equipment supplier.
- B. Supply all labor, tools, and materials required to complete the SCREEN-WASHER/COMPACTOR equipment installation.

## **PART 3 – EXECUTION**

### **3.01 INSTALLATION**

- A. Ship, store, and install the SCREEN-WASHER/COMPACTOR equipment in accordance with the manufacturer's recommendations and as shown on the Drawings.
- B. Shipping, storage, and installation instructions for the SCREEN-WASHER/COMPACTOR equipment provided by the SCREEN-WASHER/COMPACTOR Equipment Supplier are included with the shop drawings. These instructions do not necessarily represent complete instructions for this equipment. It is the Contractor's responsibility to determine what additional procedures, if any, are required to provide a fully functional and operational installation.

### **3.02 MANUFACTURER'S SERVICES**

- A. Services to be provided by the SCREEN-WASHER/COMPACTOR Equipment Supplier during installation, testing, and start-up of the equipment and for the training of the Owner's staff in the operation and maintenance of the equipment, shall be as specified in the SCREEN-WASHER/COMPACTOR Equipment supply documents.

B. Testing and Commissioning:

1. Testing and commissioning for the SCREEN-WASHER/COMPACTOR equipment shall conform to the procedures described in the SCREEN-WASHER/COMPACTOR shop drawings and the procedures specified in Section 01650, "Installation, Testing, Commissioning, and Training."
2. The manufacturer and the Contractor shall field test and calibrate the installed equipment to demonstrate that all equipment will satisfactorily perform the functions and criteria specified.
3. Manufacturer's Installation Certification Form shall be completed for equipment provided by the SCREEN-WASHER/COMPACTOR Equipment Supplier and for the Screen installation as a whole.

**END OF SECTION**

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**SECTION 01650**  
**INSTALLATION, TESTING, COMMISSIONING AND TRAINING**

**PART 1 – GENERAL**

**1.01 DESCRIPTION**

- A. This section specifies the installation, testing, commissioning, and training for all Screen-Washer/Compactor mechanical, electrical, and instrumentation systems and completed portions of the Work, functioning as completed system and a complete project.

**1.02 CONFLICTS WITH MANUFACTURER’S INSTALLATION RECOMMENDATIONS**

- A. All mechanical, electrical, and instrumentation equipment provided with Screen-Washer/Compactor shall be installed as specified per the manufacturer’s requirements. Any costs incurred by the Contractor through failure to timely notify the Owner of a difference between onsite conditions and manufacturer’s installation requirements shall be borne by the Contractor.

**1.03 SUBMITTALS**

- A. Installed Testing Procedures: The Contractor shall be solely responsible for determining, detailing and documenting the individual procedures for the installed testing, operational testing and commissioning requirements specified herein. The Contractor shall submit to the Owner details of the installed tests and inspections procedures.
  - 1. The procedures shall be divided into two distinct stages: preoperation checkout and start-up test. Testing procedures shall be carefully selected to ensure that the equipment is not damaged. The Owner may wish to be involved in preoperational checks also.
  - 2. Once the testing procedures have been reviewed by the Owner, the Owner reserves the right to add checks and tests to the prestart-up and start-up schedule submitted by the Contractor, if the Owner feels that the Contractor’s schedule is not adequate or complete.

**1.04 TESTING**

- A. Contractor shall coordinate with owner and equipment supplier to have the installation certified by Spirac representative before start-up occurs.
- B. All equipment portions of the Work included in this Contract shall be tested and inspected to prove compliance with the requirements of Spirac. Unless otherwise specified, all costs of testing, including temporary facilities and connections, shall be borne by the Contractor.
- C. No tests specified herein shall be applied until the item to be tested has been inspected and approval given for the application of such test.

D. Tests and inspection shall include:

1. The installed tests and inspections.
2. The operational testing of the Screen-Washer/Compactor system.
3. The commissioning of Screen-Washer/Compactor by Owner's personnel.

#### **1.05 DELIVERY ACCEPTANCE AND INSPECTIONS**

- A. The form of evidence of satisfactory fulfillment of delivery acceptance test and inspection requirements shall be, at the discretion of the Owner, either by tests and inspections carried out in his presence.
- B. The delivery acceptance and inspections shall be at the Contractor's expense for any equipment specified in these Contract Documents and shall include the following:
  1. Inspection of all items delivered at the site or to any authorized place of storage in order that the Owner may be satisfied that such items are of the specified quality and workmanship and are in good order and condition at the time of delivery. The Contractor shall be prepared to remove all coverings, containers, or crates to permit the Owner to conduct his inspection. Should the Owner find, in his opinion, indication of damage or deficient quality of workmanship, the Contractor shall provide the necessary documentation, or conduct such tests deemed necessary by the Owner, to demonstrate compliance.

#### **1.06 PREOPERATIONAL CHECKS AND START-UP TESTING**

- A. General: All equipment shall be tested by the Contractor to the satisfaction of the Owner before any facility is put into operation. Tests shall be as specified herein and shall be made to determine whether the equipment has been properly assembled, aligned, adjusted, and connected. Any changes, adjustments, or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the Work.
- B. Preoperation Checkout:
  1. The installed tests and inspection procedures shall incorporate all requirements of these Specifications and shall proceed in a logical, step-wise sequence to ensure that all equipment has been properly serviced, aligned, connected, and adjusted prior to operation. Preoperation checkout procedures shall include, as applicable, but not necessarily be limited to:
    - a. Piping system pressure testing and cleaning.
    - b. Electrical system testing.
    - c. Instrumentation system testing as specified by the Owner.
    - d. Alignment of equipment.

- e. Manufacturer's Certificate of Proper Installation. Screen **equipment supplier will need to certify the installation of their equipment prior to start-up.**
- f. Meet and coordinate with the Owner on site for all equipment that includes a control system (headworks screens) to ensure all control communication is agreed to and working properly before system can be certified for start-up.

C. Start-Up Test:

- 1. Once all affected equipment has been subjected to the required preoperational checkout procedures and the Owner has witnessed and has not found deficiencies in that portion of the work, individual systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these Specifications.
- 2. Start-up tests shall be performed with clean water unless otherwise required by equipment manufacturers. Costs for delivering clean water to the site shall be borne by the Contractor.

### 1.07 OPERATIONAL TESTING

- A. After completion of all start-up testing and certification by the Owner that all equipment complies with the requirements of the Specifications, the Contractor shall help coordinate an operational test.
- B. Unless otherwise noted, a time period of 3 days shall be allowed for operational test. Screen must perform through its complete design range for a period of three consecutive 24-hour days. Failure at any point in a 3-day operational test, as determined by the Owner or Owner, shall require a restart of the 3-day test period..
- C. Satisfactory completion of operational testing will be required by the Owner as a condition of determining when substantial completion has been achieved.

### 1.08 COMMISSIONING

- A. After completion of all operational testing specified herein, and certification by the Owner that the systems meet all performance requirements, commissioning will begin. The commissioning period shall be 30 consecutive days. The Owner's operations and maintenance personnel will be responsible for the operation of the facilities.
- B. The Contractor shall be available at times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being tested.
- C. During the commissioning period, the Owner shall be responsible for all normal operational costs, and the Contractor shall bear the costs of all necessary repairs or replacements, including labor and materials required to keep the portion of the facilities being commissioned operational.

**PART 2 – PRODUCTS (NOT USED)**

**PART 3 – EXECUTION**

**3.01 TESTING**

- A. General: Refer to Section 1 for testing length and requirements. Contractor shall coordinate all testing with Owner at least 30 days prior to testing. Unless otherwise noted, each test must be through the complete design range for a period listed in the Section 1.

**END OF SECTION**



**SECTION 16110**  
**CONDUIT, RACEWAYS, AND FITTINGS**

**PART 1 – GENERAL**

**1.01 SECTION INCLUDES**

- A. Provisions: Applicable provisions ANSI, EIA, IEEE and NEMA become a part of this section as if repeated herein.
- B. Work specified in other Divisions:
  - 1. Excavation and Backfill of Trenches: Division 2.
  - 2. Concrete Emplacement: Division 3.

**1.02 REFERENCE STANDARDS**

- A. American National Standards Institute (ANSI) Publications:
  - 1. C80.1 Specification for Zinc Coated Rigid Steel Conduit.
  - 2. C80.3 Specifications for Zinc Coated Electrical Metallic Tubing.
  - 3. C80.5 Specifications for Rigid Aluminum Conduit.
- B. Federal Specifications (FS):
  - 1. FS W-C-1094 W-C-1094A Conduit and Conduit Fittings, Plastic, Rigid.
  - 2. FS WW-C-540 WW-C-540A Conduit, Metal, Rigid, (Electrical, Aluminum).
  - 3. WW-C-540C Conduit, Metal, Rigid & Coupling, Elbow & Nipple, Electrical Conduit, Aluminum.
  - 4. FS WW-C-563 WW-C-563A Electrical Metallic Tubing.
  - 5. FS WW-C-566 WW-C-566C Flexible Metal Conduit.
  - 6. FS WW-C-581 WW-C-581E Intermediate Rigid Metal Conduit, Zinc Coated.
- C. National Electrical Manufacturers Association (NEMA) Publications:
  - 1. RN 1 Polyvinyl Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.
  - 2. TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation.
  - 3. TC 14 Filament-Wound Reinforced Thermosetting Resin Conduit.

D. Underwriters Laboratories (UL) Standards:

1. Six Rigid Metal Electrical Conduit.
2. 360 Liquid-Tight Flexible Steel Electrical Conduit.
3. 651 Electrical Rigid Nonmetallic Conduit.
4. 651A Type EB and A Rigid PVC Conduit and HDPE Conduit.
5. 797 Electrical Metallic Tubing.
6. 1242 Intermediate Metal Conduit.

**1.03 SUBMITTALS**

- A. Refer to Owner requirements.

**PART 2 – PRODUCTS**

**2.01 CONDUIT, RACEWAYS**

A. General:

1. Rigid steel conduit shall be used in all conduit systems, except where otherwise shown on the Drawings, where flexible conduit is required, or where these Specifications require, or allow the use of electrical metallic tubing (EMT), flexible nonmetallic tubing (ENMT), polyvinyl chloride (PVC) conduit, intermediate metal conduit, or aluminum conduit.
2. Conduit runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 7 feet or more above finished floors and not subject to mechanical damage or corrosion may be EMT, or ENMT where permitted by the NEC.
3. The minimum size raceway shall be  $\frac{3}{4}$ -inch unless indicated otherwise on the Drawings.

- B. Galvanized Rigid Steel Conduit (GRS) shall be hot-dip galvanized after fabrication, conforming to ANSI C80.1 and UL 6. Couplings shall be threaded type. Where PVC coated rigid steel conduit is called for, it shall be hot-dip galvanized, conforming to NEMA RN 1, with factory-applied PVC coating 40 mils thick.

- C. Intermediate Metal Conduit (IMC) shall be steel, hot-dip galvanized after fabrication, conforming to UL 1242.

D. Flexible Conduit:

1. Flexible metal conduit shall be liquid-tight, shall have a moisture- and oil-proof PVC jacket extruded over a galvanized, flexible steel conduit, and shall conform to UL 360.
2. Flexible conduit for hazardous locations shall be UL listed for the applicable Class, Division, and Group.

- E. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be PVC Schedule 40 (PVC-40) conduit approved for underground use and for use with 90°C wires, and shall conform to UL 651.
- F. Electrical Metallic Tubing (EMT) shall be galvanized thinwall conduit conforming to UL 797.
- G. Ducts: Ducts shall be PVC, Type EB, UL listed for concrete encased burial, conforming to NEMA Standard TC6 and UL 651A, and rated at 90°C. Base and intermediate spacers shall be interlocking plastic type made for the specific sizes of ducts used. Duct spacing shall be 7 1/2-inch center-to-center.
- H. Rigid Aluminum Conduit: Conduit shall conform to FS WW-C-540 or ANSI C80.5.
- I. Electrical Nonmetallic Tubing (ENMT): Shall be UL listed rigid, hand-bendable, corrugated non-metallic PVC tubing meeting NFPA 70 (NEC) Article 331 requirements.
- J. Fiberglass conduit shall be filament-wound reinforced resin in accordance with NEMA TC-14.

## **2.02 CONDUIT SUPPORTS**

- A. Supports for individual conduits shall be galvanized malleable iron one-hole type with conduit back spacer.
- B. Supports for multiple conduits shall be hot-dip galvanized Unistrut or Superstrut channels, or equal. All associated hardware shall be hot-dip galvanized.
- C. All channels, strut, threaded rods, nuts and clamps in corrosive areas shall be of epoxy resin reinforced fiberglass material. Provide Robroy, Superstrut, or equal.

## **2.03 FITTINGS**

- A. Fittings for use with rigid steel or IMC shall be hot dipped galvanized steel or galvanized cast ferrous metal; access fittings shall have gasketed cast covers and be Crouse-Hinds Condulets, Appleton Unilets, or equal. Provide threaded-type couplings and connectors; set-screw type and compression-type are not acceptable.
- B. Fittings for use with either rigid nonmetallic conduit or duct shall be PVC and have solvent-weld-type conduit connections. If such are not available, then the Specification for PVC coated galvanized rigid steel fittings shall apply.
- C. Fittings for flexible conduit shall be Appleton Type ST, O-Z Gedney Series 4Q, or equal.
- D. Union couplings for conduits shall be the Erickson type and shall be Appleton Type EC, O-Z Gedney 3-piece Series 4, or equal. Threadless couplings shall not be used.
- E. Bushings:
  - 1. Bushings shall be the insulated type.
  - 2. Bushings for rigid steel or IMC shall be hot dip galvanized insulated grounding type, O-Z Gedney Type HBLG, Appleton Type GIB, or equal.

- F. Conduit seals shall have zinc electroplate and shall be Crouse-Hinds Type EYS or EZS; Appleton Type EYS, ESU, or EY series; or equal.
- G. Fittings for EMT shall be compression type. Connectors shall be insulated throat type. Drive-on, crimp, spring or set screw fittings are not acceptable.
- H. Fittings for ENMT shall be snap on–snap in types specially fabricated for ENMT.
- I. Fittings for use with fiberglass conduit shall be fiberglass and as recommended by the conduit manufacturer.

#### **2.04 WIREWAYS AND AUXILIARY GUTTERS**

- A. General: Wireways shall consist of a prefabricated channel-shaped trough with hinged or removable covers, associated fittings, and supports. Straight sections shall not be longer than 5 feet. Cross-sectional dimensions shall be as indicated on the Drawings. Fittings shall consist of elbows, tees, crosses, and closing plates as required.
- B. Interior Locations: All components shall be constructed from sheet steel not less than 16 gauge and coated with a corrosion-resistant gray paint. Covers shall be held closed with screws.
- C. Exterior Locations: Wireway and associated fittings shall meet NEMA 3R/12 classifications, with gasketed closing end plates and gasketed hinged covers.
- D. Corrosive Locations: In corrosive locations provide enclosure type boxes for use as wireways. Enclosures and associated fittings shall meet NEMA 4X classifications and shall be manufactured from reinforced injection molded fiberglass or formed and welded stainless steel, and shall have gasketed closing plates and hinged and gasketed covers with spring loaded latches.

#### **2.05 SURFACE RACEWAYS**

- A. Surface metal raceways shall conform to the requirements of ANSI/NFPA 70 (the NEC) Article 352. Minimum cross-sectional area shall equal or exceed that of 1/2-inch conduit.

#### **2.06 CONDUIT SEALANTS**

- A. Moisture Barrier Types: Sealant shall be a non-toxic, non-shrink, non-hardening, putty-type, hand-applied material providing an effective barrier under submerged conditions.
- B. Fire Retardant Types: Fire stop material shall be a reusable, non-toxic, asbestos-free, expanding, putty type material with a 3-hour rating in accordance with UL 1479. Provide products indicated by the manufacturer to be suitable for the type and size of penetration.

#### **2.07 WARNING TAPE**

- A. Provide electrical warning tape in duct bank as shown on the Drawings. The tape shall be 6 inches wide, red with black lettering stating “CAUTION BURIED ELECTRIC LINE”. The tape shall be made of 6 mil polymer with 36,000 psi tensile strength.

## **PART 3 – EXECUTION**

### **3.01 CONDUIT, RACEWAY AND FITTING INSTALLATION**

- A. From pull point to pull point, the sum of the angles of all of the bends and offsets shall not exceed 270 degrees.
- B. For power, control and signal circuits, provide conduit per Conduit Use Tables below, unless specifically indicated otherwise on the Drawings:
  - 1. Exception: For raceways leaving a building above grade and then going below grade, provide PVC-coated GRS from a point 3 feet above grade to a point 5 feet from the building wall.
- C. At all boxes and equipment, provide insulated type metallic grounding bushings for metallic conduits. Bond together all conduits to provide continuity of the equipment grounding system. Size bonding conductor per code.
- D. Provide flexible conduit in lengths of not more than 18 inches or less than 6 inches at connections to motors, valves and any equipment subject to vibration or relative movement.
- E. Conduits embedded in concrete floors on grade shall be installed between grids of reinforcing steel, or shall be encased below the floors, provided the concrete is thickened in a manner satisfactory to the Engineer. Installation of conduit below the bottom of this slab is not acceptable; embedding or encasing is required.
- F. Provide galvanized rigid steel factory ells for both GRS and IMC raceways. Provide GRS for offsets in both GRS and IMC raceways.
- G. Install fiberglass conduit in accordance with the manufacturer's instructions. Connections between sections of conduit may be either glued or threaded, at the Contractor's option.
- H. Underground Raceways: Slope all underground raceways to provide drainage; for example, slope conduit from equipment located inside a building to the handhole located outside the building.
- I. Conduit Supports: Properly support all conduits as required by the NEC. Run all conduits exposed except where the Drawings indicate that they are to be embedded in the floor slab, walls, or ceiling, or to be installed underground.
  - 1. Exposed Conduits: Support exposed conduits within one foot of any outlet and at intervals not exceeding NEC requirements; wherever possible, group conduits together and support on common supports. Support exposed conduits fastened to the surface of the concrete structure by one-hole clamps, or with channels. Use conduit spacers with one-hole clamps. Coordinate conduit locations with piping, equipment, fixtures, and with structural and architectural elements. Conduits attached to walls or columns shall be as unobtrusive as possible and shall avoid windows. Run all exposed conduits parallel to building lines.

2. Group together exposed conduits in horizontal runs located away from walls and support on trapeze hangers. Arrange such conduits uniformly and neatly. Trapeze hangers shall consist of channels of adequate size, suspended by means of rods or other suitable means from the ceiling or from pipe hangers. Install such runs so as not to interfere with the operation of valves or any other equipment, and keep at least 6 inches clear of any pipe which may operate at more than 100°F. Treat cut surfaces or damaged ends with corrosion-resistant coatings such as "Devcon Z", prepared by Subox Coatings; "Galvanox Type I", prepared by Pedley-Knowles; or equal. Application shall follow manufacturer's recommendation.
  3. Conduits Embedded in Concrete: Provide concrete cover at least equal to that of the reinforcing steel, space at 3 conduit diameters apart except where they cross at angles greater than 45 degrees, and install so as not to reduce the structural integrity of the concrete element.
- J. When expansion joints are crossed, whether conduit is embedded or exposed, provide watertight expansion fittings and bonding jumpers. In hazardous locations, provide Crouse-Hinds UNF/UNV, Appleton, or equal. In unclassified locations, provide Crouse-Hinds XD, Appleton, or equal.
- K. Spare Raceways: After completing a conduit run between manholes, handholes, or pullboxes, prove the integrity of the conduit run. Use an air compressor to blow in a pull-line, then use the pull-line to pull a mandrel through the entire conduit run. Install a new <sup>3</sup>/<sub>16</sub>-inch nylon, 800 pound test pull-line which has tape measure marking every foot to indicate length. Plug the ends of the conduit, with conduit cap plugs.
- L. All penetrations through walls into or out of corrosive locations shall be made gas tight. In concrete walls, pour concrete after the conduit is in place, if possible. If not, core drill concrete or CMU walls, install conduit and caulk around it with non-shrink grout. Install conduit seal in each conduit near the penetration.
- M. All conduit penetrations through interior walls and floors shall be sealed with fire retardant type conduit sealant.
- N. Conduit Identification: In each manhole, handhole, pullbox, cabinet, motor control center or other equipment enclosure, identify each conduit using the conduit number shown on the Drawings by means of a stamped brass tag affixed with stainless steel wire; where affixing a tag is not feasible, identify conduits by stenciling. Stencil all exposed conduits for identification at least once in each room.
- O. Conduit Seals:
1. Moisture Seals: Provide in accordance with NEC paragraph 300-5(g).
  2. Gas Seals: Provide in accordance with NEC paragraph 501-5.
- P. Conduit in finished areas shall be installed concealed.
- Q. Conduit shall not be supported from T-bar ceiling suspension wires.

R. Flexible metallic conduit shall have a maximum length of 6 feet. Flexible metallic conduit shall not be considered as a ground conductor. Flexible metallic conduit shall only be installed in exposed or accessible locations.

S. Rigid PVC conduit shall be stored on a flat surface and shielded from the sun.

<b>Table 1 – Conduit Use</b>							
<b>Inside Buildings</b>							
<b>Exposed</b>				<b>Concealed</b>			
Circuit Type	Standard	Corrosive	Hazardous	Above Suspended Ceilings	In Stud Walls	Embedded In Concrete	Slab On Grade
Power & 120 Vac Control	IMC or GRS	PVC-40*	PVC Coated GRS**	IMC or GRS	IMC or GRS	GRS	GRS
Signal	IMC or GRS	PVC Coated GRS	PVC Coated GRS**	IMC or GRS	IMC or GRS	GRS	GRS

<b>Table 2 – Conduit Use</b>				
<b>Outside Buildings</b>				<b>Transition</b>
Circuit Type	Exposed	Buried In Soil	Duct Bank Encased In Concrete	Within 5 Feet of Building
Power & 120 Vac Control	IMC or GRS	PVC-40 *	PVC Type EB *	PVC Coated GRS
Signal	IMC or GRS	PVC Coated GRS	GRS	PVC Coated GRS

\* Provide ground wire sized per NEC requirements for all circuits.

\*\* PVC coated GRS in wet wells, etc., that are both hazardous and corrosive, otherwise, GRS.

T. Notes:

1. Generally, the Conduit Use Tables apply.
2. Signal circuits are those subject to RF interference or induced current. MSPs, TSPs, telephone cable, coaxial cable, and manufacturer's cables specially designed for low-level signals are all presumed to be part of signal circuits.
3. Provide fiberglass conduit where indicated on the Drawings.

### **3.02 WIREWAY INSTALLATION**

- A. Straight sections and fittings shall be solidly bolted together to be mechanically rigid and electrically continuous. Dead ends shall be closed. Unused conduit openings shall be plugged.
- B. Wireways shall be supported every 5 feet.
- C. Wireways and auxiliary gutters shall not contain wiring or control devices and shall not extend over 30 feet in length.

**END OF SECTION**



**SECTION 16120**  
**LOW VOLTAGE WIRE AND CABLE**

**PART 1 – GENERAL**

**1.01 DESCRIPTION**

- A. Removal of existing wiring and replacement with new wiring to make the new Spirac Screen electrically functional per manufacturer requirements.

**1.02 REFERENCE STANDARDS**

- A. American Society for Testing and Materials (ASTM):
  - 1. B3-74, Specification for Soft or Annealed Copper Wire.
  - 2. B8-77, Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - 3. B173-71, Specification for Rope Lay Stranded Copper Conductors Having Concentric-Stranded Members.
- B. Insulated Cable Engineers Association (ICEA):
  - 1. S-66-524, Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable.
- C. International Electrical Testing Association (NETA):
  - 1. ATS, Acceptance Testing Specifications.
- D. Underwriters Laboratories (UL) Standards:
  - 1. 44, Rubber Insulated Wire and Cable.
  - 2. 62, Flexible Cords and Fixture Wire.
  - 3. 83, Thermoplastic-Insulated Wires and Cables.
  - 4. 510, Insulating Tape.
  - 5. 719, Non-Metallic Sheath Cable.
  - 6. 1063, Stranded Conductors for Machine Tool Wire.

**1.03 SUBMITTALS**

- A. None.

## 1.04 LOCATIONS

- A. Products shall be suitable for Class 1 Division 2 areas.

## PART 2 – PRODUCTS

### 2.01 CONDUCTORS

- A. General: All conductors shall be copper. Wire or cable not specifically shown on the Drawings or specified, but required, shall be of the type and size required for the application and in conformance with the applicable code. All insulated conductors shall be identified with printing colored to contrast with the insulation color.
- B. Power and Control Conductors, 600 Volts and Below:
  - 1. Solid copper wires shall be 600 volt Type THWN, sizes #12 and #10 AWG only.
  - 2. Stranded copper wire shall be 600 volt Type THWN, Class B stranding, sizes #14 AWG and larger.
  - 3. Fixture wire shall be 600 volt, silicone rubber insulated, 200°C, UL Type SF-2, with stranded copper conductors.
  - 4. Cords shall be 600 volt, 2-conductor plus ground, Type SO, hard service, of adequate length and with grounding type plug attached, rated in amperes as shown on the Drawings.
  - 5. Control cable (CC) shall be 90°C, 600 volt, UL listed multiconductor tray cable, Type TC. Individual conductors shall be #14 AWG, unless otherwise noted. CC shall have 15-mil PVC insulation and 4-mil nylon over individual conductors; outer jacket shall be 45-mil thickness for up to seven conductor cables and 60 mil for 9 through 19 conductor cables. Control cables shall be Dekoron Type IC99; Alpha Type TC; or equal.

### 2.02 SPLICES AND TERMINATIONS OF CONDUCTORS

- A. Splices: No splicing, replace all wire required for installation and per the drawings.
- B. Terminations: Terminate all new wiring on the existing terminals where previous wiring resided.
- C. Wire markers shall be heat shrink type (Raychem; T&B; or equal). Wire numbers shall be permanently imprinted on the markers.

## **PART 3 – EXECUTION**

### **3.01 CONDUCTOR INSTALLATION**

- A. Provide the following types and sizes of conductors for the uses indicated for 600 volts or less:
1. Solid Copper, Sizes #12 and #10 AWG: As shown on the Drawings for circuits for receptacles, switches and light fixtures with screw-type terminals.
  2. Stranded Copper, Size #14 AWG and Larger, Individual Conductors or CC: As shown on the Drawings for the control of motors or other equipment. Size #14 shall not be used for power supplies to any equipment.
  3. Stranded Copper, Sizes #12 AWG and Larger: As shown on the drawings for motors and other power circuits.
  4. Stranded Copper, #6 AWG and Larger: For power feeders, provide copper, not aluminum.
  5. Fixture Wire: For connections to all fixtures in which the temperature may exceed the rating of branch circuit conductors.
- B. Color Coding: Provide color coding for all circuit conductors. Insulation color shall be white for neutrals and green for grounding conductors. An isolated ground conductor shall be identified with an orange tracer in the green body. Ungrounded conductor colors shall be as follows:
1. 120/208 Volt, 3 Phase: Red, black, and blue.
  2. 277/480 Volt, 3 Phase: Yellow, brown, and orange.
  3. 120/240 Volt, 1 Phase: Red and Black.
- C. Color coding shall be in the conductor insulation for all conductors #10 AWG and smaller; for larger conductors, color shall be either in the insulation or in colored plastic tape applied at every location where the conductor is readily accessible (e.g., enclosures, pullboxes, and junction boxes).
- D. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, putting undue stress on the cables or otherwise abrading them. No grease will be permitted in pulling cables. Only soapstone, talc, or UL listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab conduits before installing cables and exercise care in pulling, to avoid damage to conductors.
- E. Wrap all cables in manholes with fireproofing tape. Extend tape 1-inch into ducts.
- F. Cable bending radius shall be per applicable code. Install feeder cables in one continuous length unless splices are favorably reviewed.

- G. Provide an equipment-grounding conductor, whether or not it is shown on the Drawings, in any flexible conduit or any raceway in which all or any portion of a run consists of non-metallic duct or conduit. For flexible conduit, an external bonding jumper is an acceptable alternative.
- H. In panels, bundle incoming wire and cables, No. 6 AWG and smaller, lace at intervals not greater than 6 inches, neatly spread into trees and connect to their respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for cable runs, lacing is not necessary when the cable is properly installed in the duct.
- I. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange so that they will be protected from chafing and excess flexing when the hinged member is moved.

### **3.02 CONDUCTOR IDENTIFICATION**

- A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

### **3.03 FIELD TESTS**

- A. Phase Rotation: The phase rotation of all circuits shall be clockwise in sequence. The Contractor shall verify that each three-phase service, feeder and branch circuits meet this requirement. A record shall be kept at each circuit tested and, on completion, given to the Engineer for review.

**END OF SECTION**

**SECTION 16920**  
**MOTOR CONTROL CENTERS**

**PART 1 – GENERAL**

**1.01 SECTION INCLUDES**

- A. Work Included: Provide new overloads for 3 hp motor in the motor control center, complete, at the location shown on the Drawings.

**1.02 SUBMITTALS**

- A. None.

**PART 2 – PRODUCTS**

**2.01 MOTOR CONTROL CENTERS**

- A. General: The motor control center is a free-standing, completely metal enclosed, dead front, dead rear, grouped motor control.
- B. Structure and Arrangement:
  - 1. Existing.
- C. Motor Control Units:
  - 1. General: Each unit currently consists of a switch, motor circuit protector, and a magnetic starter. The combination has an interrupting rating of not less than 42,000 amperes symmetrical at 480 volts.
  - 2. Replacement overload relays shall have a field adjustable trip of 85 percent to 115 percent of heater rating. Size the overload heaters to protect the 3 hp motor. Provide two spare auxiliary contacts, one normally open and one normally closed.

**PART 3 – EXECUTION**

**3.01 INSTALLATION**

- A. Remove the 1/2 hp overload relays and install new 3 hp overload relay.

**END OF SECTION**

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