City of Yankton, SD

2014 Water Treatment Plant Improvements
Horizontal Collector Well

Construction Documents
Project Manual

VOLUME 2 OF 3

ISSUED For Bids

October 8, 2014

City Project No. ES14-5
HDR Project No. 135-223788-003

CITY OF YANKTON

SOUTH DAKOTA

PROJECT MANUAL

SPECIFICATIONS AND BID FORM

FOR

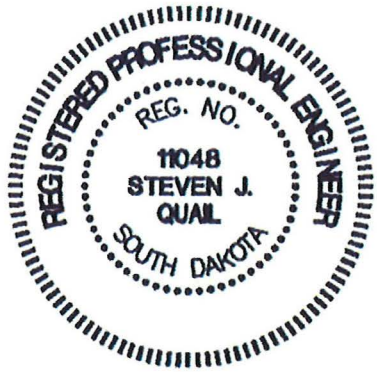
2014 Water Treatment Plant Improvements
Horizontal Collector Well

HDR Project No. 223788
City of Yankton Project No. ES14-5

CITY OF YANKTON, OWNER
PO BOX 176
YANKTON, SOUTH DAKOTA 57078

ENGINEER
HDR Engineering, Inc.
6300 S. Old Village Place
Sioux Falls, SD 57108

SEALS AND SIGNATURES



I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

Steven J. Quail 10/8/14

(Steven J. Quail) Date

My license renewal date is September 30, 2015

Pages or sheets covered by this seal:

Bidding Documents, Contract Documents, and Contract Conditions.

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

Kevin F. Newman 10/8/14

(Kevin F. Newman) Date

My license renewal date is September 30, 2016

Pages or sheets covered by this seal:

Division 02 and Sections 01010, 01020, 01060, 01060A, 01062, 01105, 01200, 01320, 01340, 01342, 01560, 01600, 01601, 01640, 01650, 01710, 01800, 11005, 11060, 11072, 13200, 15060, 15061, 15062, 15064, 15090, 15100, 15100A, 15101, 15103, 15104, 15106, 15114, and 15510

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

David F. Penner 10/08/14

(David F. Penner) Date

My license renewal date is May 31, 2016

Pages or sheets covered by this seal:

Sections 13440, 13440A, 13440B, 13440C, 13440D, 13440E, 13440F, 13441, 13442, 13446, 13447, 13448, 13449, 13500, 13502, and 13504.

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

Jeffrey A Lewis 10/8/14

(Jeffrey A. Lewis) Date

My license renewal date is September 30, 2015

Pages or sheets covered by this seal:

Sections 11077, 15183, 15515, 15605, 15710, 15890, 15970, and 15990.

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

Keith R Kirchner 10/8/14

(Keith R. Kirchner) Date

My license renewal date is November 30, 2015

Pages or sheets covered by this seal:

Sections 01452, 01452A, 01452B, 03108, 03208, 03308, 03311, 03350, 05505 and 13200.

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Architect under the laws of the State of South Dakota.

John S Rickert 10.08.2014

(John S. Rickert) Date

My license renewal date is July 31, 2015

Pages or sheets covered by this seal:

Divisions 04, 06, 07, 08, and 09 and Sections 03348, 05522, 10200, 10400, 10444, 10520 and 10530.

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under the laws of the State of South Dakota.

Kevin K. Thernes 10/8/14

(Kevin K. Thernes) Date

My license renewal date is December 31, 2014

Pages or sheets covered by this seal:

Division 16.

2014/10/02

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SECTION 09905
PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03348 - Concrete Finishing and Repair of Surface Defects.
   4. Section 04220 - Concrete Masonry.
   5. Section 05505 - Metal Fabrications.
   6. Section 10400 - Identification Devices.
   7. Section 11005 - Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      b. D4259, Standard Practice for Abrading Concrete.
      c. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      d. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      e. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      f. D4414, Standard Practice for Measure of Wet Film Thickness by Notch Gages.
      g. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. National Association of Pipe Fabricators (NAPF):
      a. 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings:
         1) 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
         2) 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
   3. National Bureau of Standards (NBS):
      a. Certified Coating Thickness Calibration Standards.
   4. National Fire Protection Association (NFPA):
      a. 101, Life Safety Code.
   5. NSF International (NSF).
   6. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors and Frames.
   7. The Society for Protective Coatings (SSPC):
      a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
      b. SP 1, Solvent Cleaning.
      c. SP 2, Hand Tool Cleaning.
      d. SP 3, Power Tool Cleaning.

e. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

8. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 5/NACE No. 1, White Metal Blast Cleaning.
   b. SP 6/NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/NACE No. 2, Near-White Blast Cleaning.
   e. SP 12/NACE No. 5, Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
   f. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
   2. Applicators shall have minimum of 10 years experience in application of similar products on similar project.
      a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
      b. Include name and address of project, size of project in value (painting) and contact person.

C. Miscellaneous:
   1. Furnish paint through one (1) manufacturer unless noted otherwise.
   2. Coating used in all corridors and stairways shall meet requirements of NFPA 101 and ASTM E84.

D. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.

E. Material shall not be thinned unless approved, in writing, by paint manufacturer's authorized representative.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in Specification Section 11005.

C. Exposed Exterior Surface:
   1. Surface which is exposed to weather but not necessarily exposed to view as well as surface exposed to view.
   2. Exterior surfaces are considered corrosive environment.
      a. The following areas are considered highly corrosive:
         1) All chemical unloading stations and areas within 10 FT-0 IN of containment areas.
         2) All chemical unloading station containment areas.
         3) All areas within a 6 FT radius of chemical tank vents.

D. Finished Area: An area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be painted.

E. Immersion Surface:
   1. Any surface immersed in water or some other liquid.
   2. Surface of any pipe, valve, or any other component of the piping system subject to condensation including the pipe support system.

F. Paint includes the following:
   1. High performance industrial coatings (HPIC) include: Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

G. Surface Hidden from View: Surfaces such as those within pipe chases, surfaces between top side of ceilings (including drop-in tile ceilings) and underside of floor or roof structures above, surfaces under overhanging walkways if over five feet above adjacent walking surfaces

H. AP: Architectural paints.

I. HPIC: High performance industrial coatings.

J. SC: Special coatings.

K. Water level for purposes of painting: See Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Applicator experience qualifications.
      a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's application instructions.
      c. Manufacturer's surface preparation instructions.
      d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section}, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
      e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
      f. Coating manufacturer's recommendation on abrasive blasting.
      g. Manufacturer's recommendation for universal barrier coat.
      h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
   4. Manufacturer's statement regarding applicator instruction on product use.
   5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

B. Samples:
   1. Manufacturer's full line of colors for Engineer's preliminary color selection.
   2. After preliminary color selection by Engineer provide two (2) 3 x 5 IN samples of each final color selected.

C. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Approval of application equipment.
   3. Applicator's daily records:
      a. Submit daily records at end of each week in which painting work is performed unless requested otherwise by Engineer's on-site representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
   1. Name or type number of material.
   2. Manufacturer's name and item stock number.
   3. Contents, by volume, of major constituents.
   4. Warning labels.
   5. VOC content.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, only the following manufacturers are acceptable:
   1. High performance industrial coatings:
      a. Tnemec.
      b. ICI Devoe.
      c. Carboline Protective Coatings.
      d. Sherwin Williams.
      e. Dampney Company, Inc.
      f. PPG Industries/Amercoat.

B. Submit request for substitution in accordance with Specification Section 01640.
   1. Product VOC content will be an important factor when determining acceptability of substitution.

2.2 MATERIALS

A. For unspecified materials such as thinner, provide manufacturer's recommended products.

B. Paint Systems - General:
   1. P = prime coat.
   2. F1, F2 . . . Fn = first finish coat, second finish coat . . . . nth finish coat, color as selected by Engineer.
   3. If two (2) finish coats of same material are required, Contractor may, at his option and by written approval from paint manufacturer, apply one (1) coat equal to mil thickness of two (2) coats specified.

C. HPIC products listed in the MATERIALS Article, Paint Systems paragraph are manufactured by Tnemec.
   1. Products of other listed manufacturers are acceptable for use providing the product is of the same generic resin, requires comparable surface preparation, has comparable application requirements, meets the same VOC levels or better, provides the same finish and color options and will withstand the atmospheric conditions of the location where it is to be applied.

D. Paint Systems (Systems not shown are not used):
   1. HPIC SYSTEM #1 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s).
      a. Prime coat:
         1) P1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      b. Finish coat(s):
         1) Interior:
            a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
            b) F2 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
         2) Exterior:
            a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).

b) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield. W.B.(Waterborne Acrylic Polyurethane).

2. HPIC SYSTEM #2 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s).
   a. Prime coat:
      1) P1 = 1 coat, 3.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
   b. Finish coat(s):
      1) Interior:
         a) F1 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) F1 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
         b) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B.(Waterborne Acrylic Polyurethane).
3. HPIC SYSTEM #3 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
   a. Prime coat:
      1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
   b. Finish coat(s):
      1) Interior:
         a) F1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) F1 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
4. HPIC SYSTEM #4 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
   a. Prime coat:
      1) P1 = 1 coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
   b. Finish coat(s):
      1) Interior:
         a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) F1 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
5. HPIC SYSTEM #5 - Modified Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
   a. Prime coat:
      1) P1 = 1 coat, 2.0 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).
   b. Finish coat(s):
      1) Interior:
         a) F1 = 1 coat, 2.5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) F1 = 1 coat, 2.0 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).
6. HPIC SYSTEM #7 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s).
   a. Prime coat:
      1) P1 = 1 coat, 2.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
   b. Finish coat(s):
      1) Interior:
         a) F1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      2) Exterior:
         a) F1 = 1 coat, 3.0 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

7. HPIC SYSTEM #8 - Air Dry Silicone Copolymer Primer with Silicone Copolymer Top Coat.
    a. Prime coat:
        1) P1 = 1 coat, 2.0 mils, Dampney Thurmalox 260C Series (Air Dry Silicone Copolymer).
    b. Finish coat:
        1) Interior or exterior:
            a) F1 = 1 coat, 2.0 mils, Dampney Thurmalox 260C Series (Air Dry Silicone Copolymer).
8. HPIC SYSTEM #10 - Modified Silicone Co-Polymer Primer with Modified Silicone Co-Polymer Top Coat(s).
    a. Prime coat:
        1) P1 = 1 coat, 4.0 to 5.0 mils, Dampney Thurmalox 225 HD (Modified Silicone Co-Polymer).
    b. Finish coat(s):
        1) F1 = 1 coat, 2.5 to 3.0 mils, Dampney Thurmalox 230C.
9. HPIC SYSTEM #15 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy Top Coat.
    a. Prime coat:
        1) P1 = 1 coat, 4 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
    b. Finish coat:
        1) Interior:
            a) F1 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
            b) F2 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
10. HPIC SYSTEM #19 - Polyamidoamine Epoxy Coating.
    a. Prime coat:
        1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
11. HPIC SYSTEM #21 - Modified Polyamidoamine Epoxy.
    a. Prime coat:
        1) P1 = 1 coat, 5 mils, 135-1243 Chembuild (Modified Polyamidoamine Epoxy).
12. HPIC SYSTEM #23 - Zinc-Rich Urethane Potable Water Approved Primer with Polyamine Epoxy Potable Water Approved Top Coats.
    a. Prime coat:
        1) P1 = 1 coat, 3 mils, Series 91 H_20 Hydro-Zinc (Zinc-Rich Urethane).
    b. Finish coat(s):
        1) Interior:
            a) F1 = 1 coat, 25 mils, Series 22 Pota-Pox 100 (Modified Polyamine Epoxy).
13. HPIC SYSTEM #24 - Vinyl Ester Primer with Vinyl Ester Top Coat.
    a. Prime coat:
        1) P1 = 1 coat, 17 mils, Series 120-5002 Vinester (Vinyl Ester).
    b. Finish coat:
        1) F1 = 1 coat, 17 mils, Series 120-5001 Vinester (Vinyl Ester).
14. SYSTEM #41 - Touch-up of galvanized surfaces not requiring a top coat.
    a. Refer to Specification Section 05505.

PART 3 - EXECUTION

3.1 ITEMS TO BE PAINTED

A. General:

B. Exposed Exterior Surfaces including:
    1. Equipment supports, and pipe supports .
    2. Piping, valves, fittings, and supports.
        a. Field welded connections of factory painted piping.
    3. Miscellaneous ferrous metal surfaces.

4. Steel pipe bollards.
5. Steel lintels.
6. Steel components of concrete lintels.
    a. Steel components shall be completely painted (with both prime and finish coats) prior to installing in the wall.
7. Galvanized metal surfaces.
8. Cast iron pipe plumbing vents.

C. Surfaces in Areas Not Considered Finished:
1. Paint following surfaces in areas not considered as finished area:
    a. Piping, valves, fittings, and supports.
    b. Ductwork and supports.
    c. Miscellaneous ferrous metal surfaces.
    d. Steel lintels.
    e. Steel components of concrete lintels.
        1) Steel components shall be completely painted (with both prime and finish coats) prior to installing in the wall.

3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article unless specifically noted in the Contract Documents to be painted.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical Equipment:
1. Do not field paint electrical equipment except where painting is specifically stated elsewhere in these Contract Documents, or where the equipment is subject to a corrosive environment and is specifically noted to be painted.

D. Other Items:
1. Stainless steel surfaces except:
    a. Piping where specifically noted to be painted.
    b. Banding as required to identify piping.
2. Aluminum surfaces except:
    a. Where specifically shown in the Contract Documents.
    b. Where in contact with concrete.
    c. Where in contact with dissimilar metals.
3. Fiberglass surfaces except:
    a. Fiberglass piping where specifically noted to be painted.
    b. Piping supports where specifically noted to be painted.
4. Interior of pipe, ductwork, and conduits.
5. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.
6. Code labels and equipment identification and rating plates.
7. Exterior concrete or precast concrete surfaces.
8. Interior surfaces of wet well.
9. Concrete stair.
10. Face brick.
11. Aluminum doors and frames.
12. Pre-colored masonry
13. Aluminum windows, curtainwall and storefront framing systems.
14. Structural aluminum.
15. Clad aluminum, clad steel, anodized aluminum.
16. Contact surfaces of friction-type connections.

17. Bituminous coated ductile iron pipe.
    a. See the ITEMS TO BE PAINTED Article, Interior Finished Areas paragraph of this Specification Section.

3.3 SCHEDULE OF ITEMS TO BE PAINTED AND PAINTING SYSTEMS

A. Steel:
    1. Potable water storage tanks and all ferrous metal items subject to contact with potable water requiring NSF approval: SYSTEM #23.
        a. Includes all ferrous metal surfaces subject to splash, spillage, vapor, condensation or other chronic potable water exposure.
        b. Also includes ferrous metal surfaces within concrete potable water storage tankage requiring NSF approval.
        c. Exterior surfaces of potable water storage tanks: SYSTEM #7.

B. Ferrous metals: SYSTEM #2.
    1. Includes ferrous, piping pumps, and similar items.
    2. Does not include items subject to contact with potable water.

C. Galvanized Metals: SYSTEM #3

D. Non-ferrous metals: SYSTEM #3.
    1. Includes copper, brass, aluminum and aluminum flashing specifically indicated on the Drawings to be painted.

E. Electrical Conduit: SYSTEM #3

F. Pipe, Valves, and Fittings:
    1. Steel pipe bollards: SYSTEM #3.
    2. Steel, cast-iron, and uncoated ductile iron not in immersion service: SYSTEM #2.
    3. Brass and bronze: SYSTEM #3.

G. Aluminum buried in concrete, between dissimilar metals and dissimilar materials: SYSTEM #19.

H. Emergency generator engine exhaust piping: SYSTEM #10.

3.4 PREPARATION

A. General:
    1. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.
        a. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
            1) Provide temporary dehumidification equipment properly sized to maintain humidity levels required by paint manufacturer.
            2) Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
                a) Vent exhaust gases to exterior environment.
                b) No exhaust gases shall be allowed to vent into the space being painted or any adjacent space.
    2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
        a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
    3. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.

4. Adhere to manufacturer's recoat time surface preparation requirements.
    a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
        1) Minimum SSPC SP 7/NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
    1. Protect surrounding surfaces not to be coated.
    2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
    1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
        a. All piping, pumps, valves, fittings and any other component used in any water piping system that requires preparation for painting shall be prepared in accordance with requirements for immersion service.
            1) Pipe: NAPF 500-03-04.
            2) Fittings: NAPF 500-03-05
        b. Prepare all areas requiring patch painting in accordance with recommendations of manufacturer and NAPF.
        c. Remove bituminous coating per piping manufacturer, paint manufacturer and NAPF recommendations.
            1) The most stringent recommendations shall apply.
    2. Complete fabrication, welding or burning before beginning surface preparation.
        a. Chip or grind off flux, spatter, slag or other laminations left from welding.
        b. Remove mill scale.
        c. Grind smooth rough welds and other sharp projections.
    3. Solvent clean in accordance with SSPC SP 1 or detergent and low-pressure water clean in accordance with SSPC SP 12/NACE No. 5 all surfaces scheduled to receive additional SSPC surface preparation.
    4. Surfaces subject to immersion service:
        a. Near-white blast clean in accordance with SSPC SP 10/NACE No. 2.
    5. Surfaces subject to high temperatures.
        a. Heat in excess of 600 DegF: SSPC SP 10/NACE No. 2.
    6. All fusion bonded epoxy coated surfaces identified to be field painted:
        a. Remove all traces of gloss finish by sanding or by abrasive brush blasting.
        b. Clean surface after removing gloss finish to remove sanding or blasting residue.
    7. Restore surface of field welds and adjacent areas to original surface preparation.
    8. Black iron piping: Remove surface varnish by solvent or waterjet and detergent cleaning or brush-off blast cleaning in accordance with SSPC SP 7/NACE No. 4.

E. Galvanized Steel and Non-ferrous Metals:
    1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 16 to remove zinc oxide and other foreign contaminants.
        a. Provide uniform 1 mil profile surface.

F. Abrasive blast clean the following equipment or surfaces regardless of previous finish, if any.
    1. Bituminous coated ductile iron pipe where exposed.

G. Concrete:
    1. Cure for minimum of 28 days.
    2. Verify that concrete surfaces have been cleaned and that voids have been patched in accordance with Specification Section 03348.
        a. Concrete surfaces shall be cleaned in accordance with ASTM D4258.

3. Mechanically abrade concrete surfaces in accordance with ASTM D4259 as recommended by coating manufacturer.
4. Abrasive blast concrete surfaces in accordance with SSPC SP 13/NACE No. 6 to provide profile recommended by coatings manufacturer.
5. Test pH of surface to be painted in accordance with ASTM D4262.
    a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
    b. Retest pH until acceptable results are obtained.
6. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
    a. Test moisture content of surface to be coated in accordance with ASTM D4263.
    b. After remedial measures have been taken to lower or raise moisture content, retest surface until acceptable results are obtained.

H. Preparation by Abrasive Blasting:
1. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
    a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
2. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
3. Perform additional blasting and cleaning as required to achieve surface preparation required.
    a. Prior to painting, reblast surfaces allowed to set overnight and surfaces that show rust bloom.
    b. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be reinspected prior to paint application.
4. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.
5. Provide compressed air for blasting that is free of water and oil.
    a. Provide accessible separators and traps.
6. Confine blast abrasives to area being blasted.
    a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
    b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
7. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
8. Reblast surfaces not meeting requirements of these Specifications.
9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation not scheduled to be reused.

I. All Plastic Surfaces and Non-Ferrous Surfaces Except Galvanized Steel:
1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.5 APPLICATION

A. General:
1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
    a. Application equipment must be inspected and approved in writing by coating manufacturer.
    b. Hollow metal shall be spray applied only.

2. Temperature and weather conditions:
    a. Do not paint surfaces when surface temperature is below 50 DegF unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
    b. Avoid painting surfaces exposed to hot sun.
    c. Do not paint on damp surfaces.
3. Provide complete coverage to mil thickness specified.
    a. Thickness specified is dry mil thickness.
    b. All paint systems are "to cover."
        1) In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern.
    c. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
4. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
5. Apply materials under adequate illumination.
6. Evenly spread to provide full, smooth coverage.
7. Work each application of material into corners, crevices, joints, and other difficult to work areas.
8. Avoid degradation and contamination of blasted surfaces and avoid intercoat contamination.
    a. Clean contaminated surfaces before applying next coat.
9. Smooth out runs or sags immediately, or remove and recoat entire surface.
10. Allow preceding coats to dry before recoating.
    a. Recoat within time limits specified by coating manufacturer.
    b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
11. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
12. Coat all aluminum in contact with dissimilar materials.
13. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.

B. Prime Coat Application:
1. Prime all surfaces indicated to be painted.
    a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
2. Ensure field-applied coatings are compatible with factory-applied coatings.
    a. Employ services of coating manufacturer's qualified technical representative.
        1) Certify through material data sheets.
        2) Perform test patch.
    b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
    c. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in the MATERIALS Article, Paint Systems paragraph of this Specification Section.
        1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.
3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
4. Apply zinc-rich primers while under continuous agitation.
5. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
6. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
7. Touch up damaged primer coats prior to applying finish coats.
    a. Restore primed surface equal to surface before damage.

8. All surfaces of steel lintels and steel components of concrete lintels used in wall construction shall be completely painted with both prime and finish coats prior to placing in wall.

C. Finish Coat Application:
1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
2. Touch up damaged finish coats using same application method and same material specified for finish coat.
a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3.6 COLOR CODING

A. Color and band piping in accordance with the SCHEDULE Article of this Specification Section.
1. Band piping using maximum of three (3) different colors at 20 FT maximum centers.
2. Factory painted piping shall be color banded in the factory per the Schedule in the SCHEDULE Article of this Specification Section.
3. Place bands:
a. Along continuous lines.
b. At changes in direction.
c. At changes of elevation.
d. On both sides of an obstruction (e.g., wall, ceiling) that painted item passes through.
4. Band width for individual colors (pipe diameter measured to outside of insulation, if applicable):
a. Piping up to 8 IN DIA: 2 IN minimum.
b. Piping greater than 8 IN up to 24 IN DIA: 4 IN minimum.
c. Piping greater than 24 IN up to 48 IN DIA: 6 IN minimum.
d. Piping greater than 48 IN DIA: 8 IN minimum.

3.7 FIELD QUALITY CONTROL

A. Contractor to provide protection for surfaces painted with epoxy coatings to prevent chalking.
1. Surfaces showing chalking will not be accepted.

B. Maintain Daily Records:
1. Record the following information during application of each coat of paint applied:
a. Date, starting time, end time, and all breaks taken by painters.
b. For exterior painting:
1) Sky condition.
2) Wind speed and direction.
c. Air temperature.
d. Relative humidity.
e. Moisture content and surface temperature of substrate prior to each coat.
f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
g. Record environmental conditions, substrate moisture content and surface temperature information not less than once every four (4) hours during application.
1) Record hourly when temperatures are below 50 DegF or above 100 DegF.
2. Record the following information daily for the paint manufacturer's recommended curing period:
a. Date and start time of cure period for each item or area.
b. For exterior painting:
1) Sky conditions.
2) Wind speed and direction.

c. Record environmental conditions not less than once every 12 hours.
1) Record once every four (4) hours when ambient temperature is below 35 DegF.
d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
3. Format for daily record to be computer generated.

C. Measure wet coating with wet film thickness gages in accordance with ASTM D4414.

D. Measure coating dry film thickness in accordance with SSPC PA 2 using Mikrotest gage calibrated against NBS "Certified Coating Thickness Calibration Standards."
1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

E. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

F. Measure substrate humidity with humidity gage specifically designed for such.

G. Provide wet paint signs.

3.8 CLEANING

A. Clean paint spattered surfaces.
1. Use care not to damage finished surfaces.

B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

3.9 SCHEDULE

A. Piping and Pipe Banding Color Schedule (Colors based on Tnemec):
1. Match piping and banding colors to Owners existing colors scheme.
2. Piping systems shown in italics with no paint color shown for the pipe but having paint colors shown for the banding color are systems that will be banded using material other than paint.
a. Refer to Specification Section 10400 for the piping system and banding material and refer to this Specification Section and this Schedule for the banding colors.
b. Collector Well Piping Schedule:

SERVICE	SYMBOL	PIPE COLOR
Collector Well Pump Discharge:	CWPDIS	110 GN - Clover
Condenser Water Return	CWR	32GR-Gray
Condenser Water Supply	CWS	32GR-Gray
Raw Water Return	RWR	32GR-Gray
Raw Water Supply	RWS	32GR-Gray
Pre-Lube	PL	32GR-Gray

END OF SECTION

1

DIVISION 10

SPECIALTIES

2014/08/29

SECTION 10200
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Louvers and vents.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 07600 - Flashing and Sheet Metal.
   4. Section 07900 - Joint Sealants.
   5. Section 08410 - Storefront.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. Air Movement and Control Association (AMCA).
   3. ASTM International (ASTM):
      a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color chart showing manufacturer's full line of colors including exotic and special colors for color selection by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Louvers:
      a. Airolite Co.
      b. Construction Specialties, Inc.
      c. Ruskin Manufacturing.
      d. Industrial Louvers, Inc.
      e. American Warming.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Louvers:
   1. 4 IN deep.
   2. Drainable with blades at 37-1/2 degrees.
   3. Continuous blade appearance.
   4. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 IN thick.
   5. Minimum free area: 8.58 SF for 4 x 4 FT louver.
   6. Maximum pressure drop: 0.10 IN of water at 700 fpm.
   7. Water penetration: 0.01 OZ/SF at 873 fpm.
   8. AMCA certified.
   9. Ruskin "ELF 375DX".
   10. Insect screen:
      a. 18-16 mesh aluminum.
      b. Install in standard aluminum frame.
   11. Glazing Adapter
      a. Extruded aluminum alloy 6063-T5.
      b. Size as required for louver model.
      c. Thickness: 0.081 IN or as required per manufacturers standard.
      d. Finish to match storefront.
      e. Coordinate with Section 08410 Storefront.

B. Anchors, Fasteners, Reinforcing: Aluminum or stainless steel.

C. Finish:
   1. Architectural Class 1 coating per AA DAF 45.
      a. Champagne, AA-M10C12C22A44.
      b. Finish matching storefront, no exceptions.

D. Size: Refer to Mechanical Drawings for louver size, and refer to Architectural Drawings for louver shapes.

E. Blank-Off Plates:
   1. Aluminum sheet, 0.050 IN minimum thickness.
   2. Factory applied flat black painted finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchoring and bracing accessories as required.
   1. Install into storefront frame with glazing adaptor.

C. Seal around perimeter on exterior and interior.
   1. See Section 07900.

D. Install 0.040 IN aluminum flashing at sill to match louver.
   1. See Section 07600.

END OF SECTION

2014/10/07

SECTION 10400
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   2. Instrumentation, Systems, and Automation Society (ISA).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. Z535.1, Safety Color Code.
      b. Z535.2, Environmental and Facility Safety Signs.
      c. Z535.3, Criteria for Safety Symbols.
      d. Z535.4, Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Catalog information for all identification systems.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
   2. Panduit.
   3. Seton.
   4. National Band and Tag Co.
   5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 IN minimum.
      b. Thickness: 0.035 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 IN minimum.
      b. Length as required by text.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Embossed.
   4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:
   1. Materials: Fiberglass reinforced plastic.
   2. Size:
      a. Surface: 2 x 2 IN minimum.
      b. Thickness: 100 mils.
   3. Fabrication:
      a. 3/16 IN mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant.
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:
   1. Materials: Fiberglass reinforced or durable plastic.
   2. Size:
      a. Surface: As required by text.
      b. Thickness: 60 mils minimum.
   3. Fabrication:
      a. Rounded corners.
      b. Drilled holes in corners with grommets.
      c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.

4. Color:
    a. Background: Manufacturer standard or as specified.
    b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Phenolic Name Plates:
1. Materials: Phenolic.
2. Size:
    a. Surface: As required by text.
    b. Thickness: 1/16 IN.
3. Fabrication:
    a. Two (2) layers laminated.
    b. Legend: Engraved through top lamination into bottom lamination.
    c. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
2. Size:
    a. Surface: As required by text.
    b. Thickness: 5 mils minimum.
3. Fabrication:
    a. Indoor/Outdoor grade.
    b. Weather and UV resistant inks.
    c. Permanent adhesive.
    d. Legend: Preprinted.
    e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
    a. Legend: Preprinted.
4. Color: White background, black printing.

I. Type F - Underground Warning Tape:
1. Materials: Polyethylene.
2. Size:
    a. 6 IN wide (minimum).
    b. Thickness: 3.5 mils.
3. Fabrication:
    a. Legend: Preprinted and permanently imbedded.
    b. Message continuous printed.
    c. Tensile strength: 1750 psi.
4. Color: As specified.

J. Type G - Stenciling System:
1. Materials:
    a. Exterior type stenciling enamel.
    b. Either brushing grade or pressurized spray can form and grade.
2. Size: As required.
3. Fabrication:
    a. Legend: As required.
4. Color: Black or white for best contrast.

K. Underground Tracer Wire:
    1. Materials:
        a. Wire:
            1) 12 GA AWG.
            2) Solid.
        b. Wire nuts: Waterproof type.
        c. Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:
    1. Bead chain: #6 brass, aluminum or stainless steel.
    2. Plastic strap: Nylon, urethane or polypropylene.
    3. Screws: Self-tapping, stainless steel.
    4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
    1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
    1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:
    1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
    2. Continuous pass from each valve box and above grade at each structure.
    3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
    4. 1,000 FT maximum spacing between valve boxes.
    5. If split bolts are used for splicing, wrap with electrical tape.
    6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
    7. Use continuous strand of wire between valve box where possible.
        a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

A. Process Systems:
    1. General:
        a. Provide arrows and markers on piping.
            1) At 20 FT maximum centers along continuous lines.
            2) At changes in direction (route) or obstructions.

3) At valves, risers, "T" joints, machinery or equipment.
4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
1) If flow is in both directions use double headed arrow markers.

c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:
a. Tag type: Type F - Underground Warning Tape
b. Location: Halfway between top of piping and finished grade.
c. Letter height: 1-1/4 IN minimum.
d. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
1) Color: Green with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED NONPOTABLE WATER LINE BELOW”

3. Yard valves, buried, with valve box and concrete pad:
a. Tag type: Type A2 - Rectangle Metal Tags.
b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
c. Legend:
1) Letter height: 1/4 IN minimum.
2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

4. Valves and slide gates:
a. Tag type:
1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
2) Indoor noncorrosive:
a) Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.
3) Indoor corrosive:
a) Stainless steel Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.

b. Fastener:
1) Type A1: Chain of the same material.
2) Type B1: Stainless steel chain.

c. Color: Per ASME A13.1 corresponding to the piping system.
d. Legend:
1) Letter height: 1/4 IN minimum.
2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

5. Process equipment (e.g., pumps, pump motors, etc.):
a. Tag type:
1) Type B2 - Nonmetallic Signs.
2) Type D - Self-Adhesive Tape Tags and Signs.
3) Type G - Stenciling System.

b. Fastener:
1) Self.
2) Screws.
3) Adhesive.

c. Legend:
1) Letter height: 1/2 IN minimum.
2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).

6. Piping systems:
a. Tag type:
1) Outdoor locations: Type G - Stenciling System.
2) Indoor locations:
a) Type D - Self-Adhesive Tape Tags and Signs.

b) Type G - Stenciling System.
b. Fastener: Self.
c. Color: Per ASME A13.1.
d. Legend:
1) Letter height: Manufacturers standard for the pipe diameter.
2) Mark piping in accordance with ASME A13.1.
3) Use piping designation as indicated on the Drawings.
4) Arrow: Single arrow.
7. Equipment that starts automatically:
a. Tag type:
1) Type B2 - Nonmetallic Signs.
2) Type D - Self-Adhesive Tape Tags and Signs.
b. Fastener:
1) Type B2 - Screw or adhesive.
2) Type D - Self.
c. Size: 5 IN x 7 IN
d. Location: Pumps.
e. Legend:
1) OSHA Warning Sign.
2) Description of Warning: “THIS MACHINE STARTS AUTOMATICALLY”.

B. Instrumentation Systems:
1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
a. Tag type:
1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
2) Indoor noncorrosive:
a) Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.
3) Indoor corrosive:
a) Stainless steel Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.
b. Fastener:
1) Type A1: Chain of the same material.
2) Type B1: Stainless steel chain.
c. Legend:
1) Letter height: 1/4 IN minimum.
2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).
2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/2 IN minimum.
2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
3. Components inside equipment enclosure, (e.g., PLC’s, control relays, contactors, and timers):
a. Tag type: Type D - Self-Adhesive Tape Tags.
b. Fastener: Self.
c. Legend:
1) Letter height: 3/16 IN minimum.
2) Description or function of component (e.g., "PLC-xxx” or “CR-xxx").
4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/4 IN minimum.

2) Component ISA tag number as indicated on the Drawings (e.g., “HS-xxx”).

C. HVAC Systems:
1. General:
a. Provide arrows and markers on ducts.
1) At 20 FT maximum centers along continuous lines.
2) At changes in direction (route) or obstructions.
3) At dampers, risers, branches, machinery or equipment.
4) Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
b. Position markers on both sides of duct with arrow markers pointing in flow direction.
1) If flow is in both directions use double headed arrow markers.
c. Apply tapes and stenciling in uniform manner parallel to ducts.
2. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):
a. Tag type:
1) Type B2 - Nonmetallic Signs.
2) Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1 IN minimum.
2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").
3. Ductwork:
a. Tag type:
1) Type D - Self-Adhesive Tape Tags and Signs.
2) Type G - Stenciling System.
b. Fastener: Self.
c. Legend:
1) Letter height: 1 IN minimum.
2) Description of ductwork, (e.g., “AIR SUPPLY”).
3) Arrows: Single arrow.
4. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/2 IN minimum.
2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").
5. Wall mounted thermostats:
a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
b. Fastener: Self.
c. Legend:
1) Letter height: 3/16 IN minimum.
2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").
6. Components inside equipment enclosure, (e.g., controller’s, control relays, contactors, and timers):
a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
b. Fastener: Self.
c. Legend:
1) Letter height: 3/16 IN minimum.
2) Description or function of component (e.g., "CR-xxx").
7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/4 IN minimum.

2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

D. Electrical Systems:
1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
a. Tag type: Type F - Underground Warning Tape.
b. Letter height: 1-1/4 IN minimum.
c. Location:
1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
d. Electrical power (e.g., low and medium voltage):
1) Color: Red with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”.
b) Second line: “BURIED ELECTRIC LINE BELOW”.
e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
1) Color: Orange with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”.
b) Second line: “BURIED COMMUNICATION LINE BELOW”.
2. Exterior pad mounted equipment (e.g., transformers, switchgear):
a. Tag type: Type D - Self-Adhesive Tape Tags.
b. Fastener: Self.
c. General legend:
1) Letter height:
a) First line: 1-1/2 IN minimum.
b) Subsequent lines: 1/2 IN minimum.
2) First line: Equipment name (e.g., "TRANSFORMER Txxx").
3) Second line: System voltage (e.g., "13,800 V: 480/277 V").
d. Each section/cubical legend:
1) Letter height: 1-1/2 IN minimum.
2) Description of source or load (e.g., "MAIN DISCONNECT" or "TO SWITCHGEAR SGxxx" or "TO TRANSFORMER Txxx").
3. Switchgear, switchboards and motor control centers:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Main equipment legend:
1) Letter height:
a) First line: 1 IN minimum.
b) Subsequent lines: 3/8 IN minimum.
2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
3) Second line:
a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
b) Include the building name or number if the source is in another building.
4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).
d. Main and feeder device legend:
1) Letter height: 3/8 IN minimum.
2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").
4. Panelboards and transformers:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.

c. Legend:
    1) Letter height:
        a) First line: 3/8 IN minimum.
        b) Subsequent lines: 3/16 IN minimum.
    2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
    3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).
    4) Third line:
        a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
        b) Include the building name or number if the source is in another building.

5. Transfer switches:
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height:
            a) First line: 3/8 IN minimum.
            b) Subsequent lines: 3/16 IN minimum.
        2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").
6. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
7. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/2 IN minimum.
        2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
8. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 3/16 IN minimum.
        2) Description or function of component (e.g., "M-xxx”, “CR-xxx” or “TR-xxx").
9. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).
10. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

11. Conductors in cable trays.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag all conductors at the same location in the tray at 50FT maximum intervals.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings.
12. Conductors in handholes and manholes.
    a. Tag type: Type A3 - Metal Tape Tags.
    b. Fastener: Nylon strap.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings.
13. Grounding conductors associated with grounding electrode system in accordance with the following:
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
14. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.
15. Power cable trays:
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location:
        1) Every 50 FT maximum.
        2) Label each barriered section of tray.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger, (e.g., “UP TO 480 VOLTS”).
16. Entrances to electrical rooms:
    a. Tag type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 5 IN x 7 IN.
    d. Location: Each door to room.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: “HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY”.
17. Equipment where more than one (1) voltage source is present:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.

e. Legend:
   1) OSHA Danger Sign.
   2) Description of Danger: “MULTIPLE VOLTAGE SOURCES”.

3.3 HAZARD AND SAFETY SIGNS

A. Provide 5 Hazard and Safety Signs:
   1. Type B2.
   2. Inscription as directed by Owner.

END OF SECTION

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SECTION 10444
SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Room identification signs.
   2. Other identification signs:

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. B26, Standard Specification for Aluminum-Alloy Sand Castings.
   3. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

1.3 DEFINITIONS

A. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the following rooms or areas are considered wet and/or corrosive:

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color charts for Engineer's color selection.
         1) Color selection shall be made from manufacturer's complete color line including all premium and special colors.
   3. Schedule of all signs indicating text and graphics.
   4. Layout drawings of all signage showing size, letter style, text, border, finish, and installation detail.
      a. Provide drawings for:
         1) Room identification signs.
         2) Aluminum letters.

B. Samples:
   1. Room identification signs.
   2. Aluminum letters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Room identification signs:
      a. Andco.
      b. ASE - Architectural Signs and Engraving.
      c. ASI Sign Systems.
      d. Best Manufacturing Co.
      e. Mohawk Engraving Co., Inc.
      f. Nelson-Harkins.
      g. Southwell.
      h. The Supersine Co.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Room Identification Signs:
   1. Exterior: Aluminum or fiberglass suitable for raised lettering and Braille.

2.3 FABRICATION

A. Room Identification Signs:
   1. General:
      a. Raised text, border and graphics.
         1) Minimum 1/32 IN height.
         2) Provide international graphic symbology for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
         3) Provide handicap symbol on all signs for rooms meeting handicap requirements.
      b. Grade 2 Braille.
      c. Finish: Eggshell.
         1) Color: To be selected.
      d. Text:
         1) Typeface: Sans Serif.
         2) Size: Minimum 3/4 IN high.
         3) Line 1: Collector Well.
         4) Line 2: Authorized Personnel Only.
      e. Size: 4 IN high (at sides) and 5 IN at high point of radius top x 6 IN wide.
      f. Exterior signs shall be rated for exterior use.
      g. All signs shall comply with requirements of ADA.

B. Hazard Communication Signage (OSHA signage): See Specification Section 10400.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Room Identification Signs:
   1. Install signs on walls adjacent to the latch side of doors using foam tape for interior signs and stainless steel screws (minimum of two (2)) for exterior signs.
      a. Stainless steel screws shall be painted to match sign color.
   2. Where no adjacent wall space is available, mount signs on nearest adjacent wall.
      a. Mounting of signs shall be such that a person may approach to within 3 IN of sign without encountering any protruding objects or standing in swing of door travel.
   3. Mount 60 IN above finish floor to centerline of sign.

END OF SECTION

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SECTION 10520
FIRE EXTINGUISHER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire extinguishers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 10, Standard for Portable Fire Extinguishers.
   2. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire extinguishers:
      a. J. L. Industries.
      b. Larsen's Manufacturing Co.
      c. Modern Metal Products.
      d. Amerex Corporation.

e. Ansul Fire Protection.
f. Walter Kidde.
g. Potter - Roemer Inc.
2. Fire extinguisher signs:
a. Seton.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Fire Extinguisher (FEXT):
1. Steel bodied, all metal top (head) and valves.
2. Multi-purpose dry chemical with hose and horn.
3. Provide one (1) UL rated 10A-120BC extinguisher for each fire extinguisher location (FEXT) indicated on Drawings.
4. Finish: Red with epoxy finish coat.

B. Wall Brackets:
1. Bracket type to fit specified extinguisher.
2. Furnish bracket for each extinguisher not in cabinet.
3. Bracket to be finished in red or black enamel.

C. Fire Extinguisher Signage:
1. Single faced: SETON #21999.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and NFPA 10.
1. Install units with extinguisher top not over 48 IN above floor.
2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.
a. See Specification Section 05505.

B. Fire extinguisher locations shown on Drawings are approximate locations.
1. Verify all extinguisher mounting locations with the AHJ.

C. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

END OF SECTION

2014/10/07

SECTION 10530
ALUMINUM CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Prefabricated aluminum canopies.

B. Related Specification Sections:
   1. Division 00 - Bidding Requirements, Contract Forms and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 2604, Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
   2. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Engineer for contractor-designed canopy systems and components: Professional Civil or Structural engineer licensed in the State of South Dakota.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Connections.
   4. Manufacturer's standard load tables.
   5. Design calculations prepared and signed by an Engineer registered in the State where project is located.
      a. Calculations shall include all connections to structure.
      b. Indicate design live loads.
      c. Engineer will review for general compliance with Contract Documents.
   6. Fabrication and/or layout drawings.
      a. Submit drawings for all fabrications and assemblies.
         1) Include erection drawings, plans, sections, details and connection details.

B. Samples:
   1. Submit three (3) color samples a minimum of 4 IN x 4 IN one of which to be retained by the Engineer. Color chart is not acceptable.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

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

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. E.L. Burns.
   2. Dittmer.
   3. Perfection.
   4. Mapes Panels.
   5. Superior Metal.
   6. Peachtree Protective Covers.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Basis of Design: Mapes Canopies, Super Lumideck series.

B. Structural Framing System:
   1. All extruded aluminum system, aluminum alloy 6063-T6.
      a. Yield: 31,000 psi.
      b. Ultimate strength: 35,000 psi.
      c. Hanger rod configuration: Perpendicular, see Drawings.
   2. Radius-cornered aluminum tubular extrusions of sizes shown on the Drawings.

C. Deck:
   1. Extruded aluminum alloy 6063-T6.
      a. Interlocking Decking: 2-3/4 IN extruded aluminum.
      b. Decking thickness: 0.078 IN.
   2. Size and profile as shown on the Drawings.

D. Fascia:
   1. Extruded aluminum alloy 6063-T6.
   2. Standard 8 IN extruded J style.

E. Fasteners:
   1. Deck: Manufacturer's standard.
   2. Trim: Aluminum rivets.
   3. Others: Stainless steel.

F. Finish:
   1. Canopy Assembly:
      a. Fluoropolymer coating:
         1) 70 percent PVDF resin based fluoropolymer, AAC12C42R1, custom color as selected by Engineer.
            a) Two (2) coat application: Comply with AAMA 2604.
            b) Color: Antique Bronze.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Loads:
   1. Design wind and snow loading is shown on the Drawings.
      a. Design shall consider uplift forces on canopy due to wind loading.
   2. Collateral loads: Additional loads imposed by other materials or systems identified in Contract Documents.

B. Structural Design:
   1. Prepare complete structural design calculations for canopy members.
      a. All connections shall be mechanical fasteners with a minimum shear stress of 350 LBS.

C. Expansion and Contraction:
1. Roof deck and fascia shall be designed with a maximum of one (1) end of each member fastened rigidly.
a. All other fasteners shall allow movement of deck and fascia.
2. Deck and fascia shall be designed to allow movement for temperature changes of at least 200 DegF.

2.4 FABRICATION AND MANUFACTURE

A. Prefabricated canopies shall be shipped in preassembled sections for ease of installation.

B. Bents:
1. Columns and beams heliarc welded together to form one-piece rigid bents.
2. Provide beam ties at every other deck projection.
3. Water shall drain into gutters.
a. Downspouts shall carry water from gutters to grade level discharge.

C. Deck:
1. Interlocking, self-flashing joints.
a. Joints fastened at 8 IN OC.
2. Cambered to neutralize deflection and to provide drainage.
3. Slope toward gutter.

D. Fascia:
1. Manufacturer's standard.
2. Allow for expansion and contraction.
3. Provide square wall escutcheons plates at all hanger rod locations. Form escutcheons to the texture of the wall.

E. Gutters and Downspouts:
1. Manufacturer’s standard.
2. Watertight and secured.
3. Drain away from existing structures.
4. Concealed drainage. Water shall drain from covered surfaces into intermediate trough and be directed to Downspout from Fascia.
5. Drainage outlet location at door canopy locations shall be placed on the hinge side of the door.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine building surfaces to which canopy will connect.

B. Coordinate with responsible trade to perform corrective work on unsatisfactory footings or surfaces.

C. Commencement of Work by installer is acceptance of existing conditions.

3.2 ERECTION

A. Erect protective covers in accordance with manufacturer's installation instructions.

B. Set bents plumb, straight, and true to line, adequately braced to maintain position until grout has cured.

C. Keep aluminum surfaces from direct contact with ferrous metal or other incompatible materials by applying one (1) coat of zinc chromate primer.
1. Follow with two (2) coats of aluminum paint.
2. In lieu of aluminum paint, one (1) coat of high-build bituminous paint applied to 1/16 IN (1.6 mm) thickness may be used.

3.3 CLEANING

A. Clean surfaces soiled by Work as recommended by manufacturer.

B. Remove surplus materials and debris from the site.

3.4 PROTECTION

A. Protect finished aluminum surfaces from damage due to subsequent construction operations.

END OF SECTION

DIVISION 11

EQUIPMENT

2014/08/14

SECTION 11005
EQUIPMENT: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 03308 - Concrete, Materials and Proportioning.
   4. Section 05505 - Metal Fabrications.
   5. Section 07900 - Joint Sealants.
   6. Section 09905 - Painting and Protective Coatings.
   7. Section 10400 - Identification Devices.
   8. Division 11 - Equipment.
   9. Division 12 - Furnishings.
   10. Section 13442 - Primary Elements and Transmitters.
   11. Division 14 - Conveying Systems.
   12. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.
   13. Division 16 - Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. ASTM International (ASTM):
      a. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   4. Hydraulic Institute (HI):
      a. 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Valves.
   5. International Electrotechnical Commission (IEC).
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   7. International Organization for Standardization (ISO):
      a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
   8. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG 1, Motors and Generators.
   9. InterNational Electrical Testing Association (NETA):
      a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
   10. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors, Motor Circuits, and Controllers.
   11. National Institute for Certification in Engineering Technologies (NICET).
   12. National Institute of Standards and Technology (NIST).

13. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
14. Underwriters Laboratories, Inc. (UL).
    a. 508, Standard for Safety Industrial Control Equipment.
    b. 508A, Standard for Safety Industrial Control Panels.
15. Vibration Institute.

B. Vibration Testing Program:
    1. Testing firm:
        a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
        b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
    2. Field personnel:
        a. Minimum of one (1) year field experience covering all phases of field vibration testing and data gathering.
        b. Qualified Vibration Category I certification from the Vibration Institute.
    3. Analysis personnel:
        a. Minimum three (3) years combined field testing and data analysis experience.
        b. Qualified Vibration Category II certification from the Vibration Institute.

C. Electrical Equipment and Connections Testing Program:
    1. Testing firm:
        a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
        b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
    2. Field personnel:
        a. Minimum of one (1) year field experience covering all phases of electrical equipment inspection, testing, and calibration.
        b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
        c. Supervisor certified by NETA or NICET.
    3. Analysis personnel:
        a. Minimum three (3) years combined field testing and data analysis experience.
        b. Supervisor certified by NETA or NICET.

D. Miscellaneous:
    1. A single manufacturer of a "product" to be selected and utilized uniformly throughout Project even though:
        a. More than one (1) manufacturer is listed for a given "product" in Specifications.
        b. No manufacturer is listed.
    2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations and defined in Division 16.
    3. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and sure their compatibility.

1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:
    1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;

2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:
1. One (1) or more assemblies capable of performing a complete function.
2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
1. General for all equipment:
a. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
b. Data sheets that include manufacturer's name and complete product model number.
1) Clearly identify all optional accessories that are included.
c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
d. Manufacturer's delivery, storage, handling, and installation instructions.
e. Equipment identification utilizing numbering system and name utilized in Drawings.
f. Equipment installation details:
1) Location of anchorage.
2) Type, size, and materials of construction of anchorage.
3) Anchorage setting templates.
4) Manufacturer's installation instructions.
g. Equipment area classification rating.
h. Shipping and operating weight.
i. Equipment physical characteristics:
1) Dimensions (both horizontal and vertical).
2) Materials of construction and construction details.
j. Equipment factory primer and paint data.
k. Manufacturer's recommended spare parts list.
l. Equipment lining and coatings.
m. Equipment utility requirements include air, natural gas, electricity, and water.
n. Ladders and platforms provided with equipment:
1) Certification that all components comply fully with OSHA requirements.
2) Full details of construction/fabrication.
3) Scaled plan and sections showing relationship to equipment.
2. Mechanical and process equipment:
a. Operating characteristics:
1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
2) Brake horsepower requirements.
3) Copies of equipment data plates.
b. Piping and duct connection size, type and location.
c. Equipment bearing life certification.
d. Equipment foundation data:
1) Equipment center of gravity.

2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

3. Electric motor:
   a. Motor manufacturer and model number.
   b. Complete motor nameplate data.
   c. Weight.
   d. NEMA design type.
   e. Enclosure type.
   f. Frame size.
   g. Winding insulation class and temperature rise.
   h. Starts per hour.
   i. Performance data:
      1) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load
      2) Guaranteed minimum power factor at 100 percent, 75 percent, and 50 percent of full load.
   j. Fabrication and/or layout drawings:
      1) Dimensioned outlined drawing.
      2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
   k. Certifications:
      1) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
         a) Include minimum speed at which the motor may be operated for the driven machinery.
   l. Electrical gear:
      1) Unless specified in a narrow-scope Specification Section, provide the following:
         a) Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
      2) Control panels:
         a) Panel construction.
         b) Point-to-point ladder diagrams.
         c) Scaled panel face and subpanel layout.
         d) Technical product data on panel components.
         e) Panel and subpanel dimensions and weights.
         f) Panel access openings.
         g) Nameplate schedule.
         h) Panel anchorage.
4. Systems schematics and data:
   a. Provide system schematics where required in system specifications.
      1) Acknowledge all system components being supplied as part of the system.
      2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
      3) Provide technical data for each system component showing compliance with the Contract Document requirements.
      4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.
5. For factory painted equipment, provide paint submittals in accordance with Specification Section 09905.
6. Qualifications for :
   a. Vibration testing firm and personnel.
   b. Electrical equipment and connections testing firm and personnel.
7. Testing plans, in accordance with PART 3 of this Specification Section:
   a. Vibration testing.
   b. Electrical equipment and connection testing.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 3304 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. Sample form letter for equipment field certification.
   2. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
   3. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
   4. Field noise testing reports if such testing is specified in narrow-scope Specification Sections.
   5. Notification, at least one (1) week in advance, that motor testing will be conducted at factory.
   6. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
   7. Motor test reports.
   8. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
   9. Provide three (3) bound final written reports documenting vibration monitoring and testing for specified equipment.
      a. Include the acceptance criteria of all equipment tested.
      b. Provide individual tabbed sections for information associated with each piece of tested equipment.
   10. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
   11. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
   12. Certification that driven equipment and VFD are compatible.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Motors:
      a. U.S. Motors.
      b. General Electric
      c. Marathon Electric

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. General:
   1. Furnished equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
   2. Execute pre-demonstration requirements in accordance with Specification Section 01650.
   3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
   4. Provide testing of electrical equipment and connections in accordance with Division 16.

5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
    a. Contract Drawings and Specifications.
    b. Related construction change documentation.
    c. Approved Shop Drawings.
    d. Approved Operation and Maintenance Manuals.
    e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:
    1. Approved in accordance with Shop Drawing submittal schedule.
    2. Included as a minimum:
        a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
        b. List and description of testing and analysis equipment to be utilized.
        c. List of all equipment to be testing, including:
            1) Name and tag numbers identified in the Contract Documents.
            2) Manufacturer's serial numbers.
            3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
    1. Minimum calibration frequency:
        a. Field analog instruments: Not more than 6 months.
        b. Field digital instruments: Not more than 12 months.
        c. Laboratory instruments: Not more than 12 months.
        d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
    2. Carry current calibration status and labels on all testing instruments.
    3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
    1. Provide reports with tabbed sections for each piece of equipment tested.
    2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
        a. Include legible copies of all forms used to record field test information.
    3. Prior to start of testing, submit one (1) copy of preliminary report format for Engineer review and comment
        a. Include data gathering and sample test report forms that will be utilized.
    4. In the final report, include as a minimum, the following information for all equipment tested:
        a. Equipment identification, including:
            1) Name and tag numbers identified in the Contract Documents.
            2) Manufacturer's serial numbers.
            3) Other pertinent manufacturer identification,
        b. Date and time of each test.
        c. Ambient conditions including temperature, humidity, and precipitation.
        d. Visual inspection report.
        e. Description of test and referenced standards, if any, followed while conducting tests.
        f. Results of initial and all retesting.
        g. Acceptance criteria.
        h. "As found" and "as left" conditions.
        i. Corrective action, if required, taken to meet acceptance.
        j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
        k. Instrument calibration dates of all instruments used in testing.
    5. Provide three (3) bound final reports prior to Project final completion.

E. Vibration Monitoring and Testing Program:
   1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
   2. Provide third party vibration testing on all rotating and reciprocating equipment having driver 25 HP and greater.
   3. Additional requirements for vibration monitoring and testing equipment:
      a. Frequency response: 0.18 Hz to 25 kHz.
      b. Resolution: 6400 lines.
      c. Amplitude range: 18 bit for 96 dB dynamic range.
      d. Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
      e. Capable of two-place computer balancing.
      f. Requirements for vibration sensor:
         1) Sensitivity: +/- 5 percent at 25 DegC= 100 mV/g.
         2) Acceleration range: 80 g peak.
         3) Amplitude nonlinearity: 1 percent.
         4) Frequency response:
            a) +/- 5 percent = 3-5000 Hz.
            b) +/- 10 percent = 1-9000 Hz.
         5) Permanently attach vibration test and monitoring mounting pads to mechanical equipment at location recommended by the equipment manufacturer or as recommended by the testing firm.
         6) Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria.
         7) Acceptability of pumping equipment to be based on the latest edition of HI 9.6.4 criteria.
         8) Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Electrical Equipment and Connections Testing Program:
   1. Perform testing on Division 16 equipment and connections in accordance with Division 16 requirements.
   2. Testing of motors:
      a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 100 HP or above.
      b. Bump motor to check for correct rotation.
   3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

G. Other Testing:
   1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
   2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
      a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

H. Electric Motors:
   1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
   2. Design for frequent starting duty equivalent to duty service required by driven equipment.
   3. Design for full voltage starting.
   4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
   5. Size for altitude of Project.
   6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.

7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
8. AC electric motors less than 1/3 HP:
    a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
    c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
9. AC electric motors 1/3 to 1 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
        1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
10. AC electric motors 1-1/2 to 10 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
11. AC electric motors greater than 10 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
        1) Design bearing life for 90 percent survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
        2) For motors greater than 100 HP, design bearing life for 90 percent survival rating at 100,000 HRS of operation.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
    d. Thermal protection:
        1) For motors 50 HP and above controlled from a variable frequency drive and for all other motors 100 HP and above, provide integral thermal detectors with normally closed contacts that will open on overtemperature complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.
            a) Two (2) thermal sensing devices per phase in each phase hot-spot location.
            b) Monitor and alarm panel:
                (1) For constant speed motors, install panel in and energize from the motor starter equipment.
                (2) For variable speed motors, install panel in and energize from the variable speed drive equipment.
12. Severe duty motor to have the following minimum features:
    a. All cast iron construction.
    b. Gasketed conduit box.
    c. Epoxy finish for corrosion protection.
    d. Hydroscopic varnish on windings for corrosion protection.
    e. Drain plug and breather.

I. NEMA Design Squirrel Cage Induction Motors:
1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
4. For use on variable frequency type adjustable speed drives, provide:
    a. Induction motors that are in compliance with NEMA MG 1, Part 31.
    b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
    c. Insulated drive end bearing on all motors.

d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
e. An insulated bearing carrier on both ends for vertical shaft motors 100 HP and larger.
f. Shaft grounding ring on all motors:
1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.

5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DegC ambient.
6. Design motors for continuous duty.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.
a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.
8. Motor enclosure and winding insulation application:
a. The following shall apply unless modified by specific Specification Sections:

MOTOR LOCATION	MOTOR ENCLOSURE / WINDING INSULATION
Unclassified Indoor Areas	WP-1, Standard Insulation
Wet indoor Areas	TEFC, Standard Insulation
Wet outdoor Areas	TEFC, Extra Dip and Bake for Moisture

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.

J. Submersible Motors: Refer to individual narrow-scope Specification Sections for submersible motor requirements.

2.3 ACCESSORIES

A. Guards:
1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
2. Interior applications:
a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. Exterior applications:
a. Construct from 16 GA stainless steel or aluminum.
b. Construct to preclude entrance of rain, snow, or moisture.
c. Roll to conform to shaft or coupling surface.
d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
1. Cast-in-place anchorage:
a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
c. Provide two (2) nuts for each bolt.
2. Drilled anchorage:
a. Adhesive anchors per Specification Section 05505.

b. Epoxy grout per Specification Section 03308.
c. Threaded rods same as cast-in-place.

C. Data Plate:
1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:
1. Provide gages in accordance with Specification Section 13442.
2. Provide at the following locations:
a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
b. At locations identified on Drawings.
3. Utilize tapping sleeves for mounting per Specification Section 15060.

E. Lifting Eye Bolts or Lugs:
1. Provide on all equipment 50 LBS or greater.
2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

2.4 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that can not be properly prepared and painted.
1. When such back to back fabrication can not be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Specification Section 07900.

I. Critical Speed:
1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
2. Excessive vibration is sufficient cause for equipment rejection.
3. Ratio of all rotative speeds to critical speed of a unit or components: Greater than 1.2.

J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
1. Manufacturer’s standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.

2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
3. Affix entire assembly with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to delivery.
    a. Control panels without an affixed UL 508A label shall be rejected.

2.5 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:
1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Specification Section 09905 to receive field painting.
    a. Field painted equipment: See Specification Section 09905 for factory applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Specification Section 09905.
1. See Specification Section 09905 for factory applied primer/field paint compatibility requirements.

2.6 SOURCE QUALITY CONTROL

A. Motor Tests:
1. Test motors in accordance with NEMA and IEEE standards.
2. Provide routine test for all motors.
3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
    a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
    b. The Contractor shall pay all costs, including shipping and handling, for all motors failing the tests.
    c. If two (2) successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
1. Route clear of major traffic areas and as approved by Engineer.

D. DO NOT construct foundations until major equipment supports are approved.

E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

F. Equipment Base:
1. Construct level in both directions.
2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Base:
1. Mount machine base of rotating equipment on equipment base.
    a. Level in both directions, using a machinist level, according to machined surfaces on base.

2. Level machine base on equipment base and align couplings between driver and driven unit using steel blocks and shims.
    a. Size blocks and shims to provide solid support at each mounting bolt location.
        1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.
    b. Provide blocks and shims at each mounting bolt.
        1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
    c. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

H. Couplings:
1. Align in the annular and parallel positions.
    a. For equipment rotating at 1200 rpm or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
        1) Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
    b. For equipment rotating at speeds greater than 1200 rpm allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:
1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
    a. Extend dam or formwork to cover leveling shims and blocks.
    b. Do not use nuts below the machine base to level the unit.
2. Saturate top of roughened concrete subbase with water before grouting.
    a. Add grout until entire space under machine base is filled to the top of the base underside.
    b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
    a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
    b. When the grout has fully hardened (after a minimum of seven (7) days) tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
    c. Recheck driver-driven unit for proper alignment.

3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
1. Has been properly installed and lubricated.
2. Is in accurate alignment.
3. Is free from any undue stress imposed by connecting piping or anchor bolts.
4. Has been operated under full load conditions and that it operated satisfactorily.
    a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.
   1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Specification Section 10400.

3.4 FIELD PAINTING AND PROTECTIVE COATINGS

A. For required field painting and protective coatings, comply with Specification Section 09905.

3.5 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.
   1. Wrapping thickness shall be 150 percent of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.6 FIELD QUALITY CONTROL

A. Furnish equipment manufacturer services as specified in the individual equipment Specifications.

B. Inspect wire and connections for physical damage and proper connection.

C. After installation and prior to energizing the motor, provide insulation resistance test of all motors 100 HP and above.
   1. Conduct test with 500 or 1000 Vdc megger.
   2. Test each phase separately.
   3. Disconnect all extraneous leads to the motor.
   4. Comply with NEMA MG 1 safety requirements and test procedures.

D. Bump motor to check for correct rotation:
   1. Ensure motor has been lubricated.
   2. Check prior to connection to driven equipment.

E. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs and cross member that are cast welded or bolted, shall be tested for a natural frequency of vibration after equipment is mounted.
   1. Keep the ratio of the natural frequency of the structure to the frequency of the disturbing force out of the range from 0.5 to 1.5.

F. Equipment Vibration Monitoring and Testing:
   1. Utilize an Engineer approved testing agency to perform vibration monitoring and testing on equipment defined in the schedule at the end of this Section.
   2. Permanently attach vibration test and monitoring mounting pads to the equipment at locations recommended by the equipment manufacturer or as recommended by the vibration testing agency.
   3. Utilize mounting pads suitable for permanent installation and for incorporation into a predictable maintenance program.
   4. For variable speed equipment provide vibration testing at 1 Hz increments throughout entire operating range.
   5. Diagnosis to include, but is not limited to the following:
      a. Unbalance.

b. Misalignment.
c. Bent shaft.
d. Journal bearing related problems.
e. Rolling contract bearing problems.
f. Mechanical looseness.
g. Resonance.
h. Foundation flexibility.
i. Electrically induced problems.
j. Pump problems.
k. Fan problems.
l. Coupling problems.
m. Drive belt problems.
n. Gear problems.
o. Centrifugal compressor problems.
p. Electric motor induced vibration from VFD or VFD carrier frequency.

6. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.
7. Tolerances for pumping equipment shall be per the latest edition of HI published standards.
8. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
9. Document testing with written report.
   a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.

3.7 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01650.

END OF SECTION

2014/10/07

SECTION 11060
PUMPING EQUIPMENT: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pumping equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.
   4. Section 11005 - Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Hydraulic Institute (HI):
      a. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

B. Fully coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 11005.

1.3 DEFINITIONS

A. The abbreviations are defined as follows:
   1. IPS: Iron Pipe Size.
   2. NPSHR: Net Positive Suction Head Required.
   3. TDH: Total Dynamic Head.
   4. TEFC: Totally Enclosed Fan Cooled.
   5. VFD: Variable Frequency Drive.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Product technical data including:
      a. Performance data and curves with flow (gpm), head (FT), horsepower, efficiency, NPSH requirements, submergence requirement.
      b. Pump accessory data.
      c. Bearing supports, shafting details and lubrication provisions.
         1) Bearing life calculations.
         2) Critical speed calculations.
      d. Solids passage information.
   4. Certifications:
      a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.

5. Test reports:
    a. Factory hydrostatic test.

B. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
1. Certifications:
    a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pumps:
    a. See individual pump Specification Sections.
2. Mechanical seals:
    a. Chesterton.
    b. Garlock.
    c. Or as noted in the individual pump Specification Sections.
3. Seal water station:
    a. Chesterton.
    b. John Crane.
    c. AESSEAL.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to shut-off condition.

2.3 ACCESSORIES

A. See Specification Section 11005.

B. Each Unit:
1. Lifting eye bolts or lugs.
2. Plugged gage cock connection at suction and discharge nozzles.
3. Tapped and plugged openings for casing and bearing housing vents and drains.
4. Fittings for properly adding flushing lubricant.
5. Pressure relief fittings for grease lubrication.

C. Mechanical Seals: Provide as specified in the narrow-scope pump sections.

D. Seal Water Station:
1. Provide one (1) unit per pump with manual shut-off valve on all pumps with seals.
2. Features:
    a. Pressure regulating.
    b. Flow regulating.
    c. Cleanable flow tube(s) while in service.
    d. Hose barb connection.
    e. Liquid filled pressure gage.

3. Materials of construction:
    a. Flowmeter tubes: Polysulfone.
    b. Unit body: Polyoxymethylene.
    c. Pressure gage: 316 stainless steel case and wetted parts.
    d. Pressure regulating valve: 316 stainless steel.
    e. Flow regulating valve: 316 stainless steel.
    f. Tube fittings: 316 stainless steel.
    g. Mounting brackets: 316 stainless steel.
4. Service:
    a. Temperatures up to 150 DegF.
    b. Pressure up to 140 psig.
5. Connection:
    a. Hose barb threaded to pump.
    b. Hose barb to seal water unit.
    c. Reinforced polyurethane hose:
        1) Minimum size: 3/8 IN ID.
        2) Minimum pressure rating:
            a) At 180 DegF: 115 psi.
            b) At 73 DegF: 200 psi.
        3) Minimum wall thickness: 1/8 IN.
    d. Non-potable water to shut-off valve: Cooper with bronze isolation valve.
6. Mounting:
    a. To pump or pipe flange with stainless steel bracket.
    b. Maximum distance from non-potable water to shut-off ball valve to seal water station and seal water station to pump seal, 2 FT each direction.

2.4 FABRICATION

A. Pump Support:
1. Design base to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
4. Mount vertical pumps on single piece pedestal baseplate.
5. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.5 SOURCE QUALITY CONTROL

A. If specifically required in the individual pump specification sections, provide factory tests:
1. All units:
    a. Conduct tests in accordance with HI.
        1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per HI 14.6.
    b. Hydrostatic test at 150 percent of shut-off head for a minimum of 5 minutes.
2. Adjustable speed units:
    a. Head (FT) verses flow (gpm) pump curves:
        1) Maximum, minimum and two (2) equally spaced intermittent speeds.
        2) Efficiencies along each curve.
        3) Brake horsepower along each curve.
3. Constant speed units:
    a. Head (FT) versus flow (gpm) pump curves:
        1) Efficiencies along curve.
        2) Brake horsepower along each curve.
4. Results certified by a registered professional engineer.

B. Statically and dynamically balance each pump per HI standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 11005.

B. Floor or Pad-Mounted Units (Non-Submersible):
   1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
   2. Assure no unnecessary stresses are transmitted to equipment flanges.
   3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
   4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
   5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
   6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
   7. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
      a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      b. Realign as necessary, install flange bolts and make equipment connection.
   8. Field paint units as defined in Specification Section 09905.
   9. Provide pressure gage on discharge of all pumps and on suction and discharge of all non-submersible units.

C. Submersible Units:
   1. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
      a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      b. Realign as necessary, install flange bolts and make equipment connection.
   2. Field paint units as defined in Specification Section 09905.
   3. Provide pressure gage on discharge of all pumps and on suction and discharge of all non-submersible units.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start adjustments and installation checks.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Instruct Owner's personnel for the specified minimum number of hours at jobsite per Specification Section 01060 on operation and maintenance of each of following pumping equipment:
      a. Section 11072 - Pumping Equipment: Vertical Turbine Line Shaft, 24 HRS.

END OF SECTION

2014/10/08

SECTION 11072

PUMPING EQUIPMENT: VERTICAL TURBINE (LINE SHAFT)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Vertical turbine well pumps.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 11060 - Pump Equipment: Basic Requirements.
   5. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. Society of Automotive Engineers (SAE).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 WARRANTY

A. A two-year warranty shall be provided. The warranty date will start from the time of project acceptance and will be one (1) date for all equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Peerless.
   2. Engineer Approved Equivalent.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Parameters:
   1. Collector Well Pumps, CWP-01, CWP-02, CWP-03:
      a. Primary design condition: 4,200 gpm at 140 FT TDH, with minimum 86 percent bowl efficiency at maximum speed.
      b. Secondary design conditions:
         1) 4,200 gpm at 73 FT TDH.

2) 2,000 gpm at 104 FT TDH.
3) 2,000 gpm at 60 FT TDH.

c. Maximum motor speed: 1,200 rpm (Variable Frequency Drive).
d. Drive motor: 200 HP (Maximum).
e. Minimum shutoff head at 100 percent Speed: 183 FT.
f. Discharge/Column Size: 16 IN.
g. Type of discharge head: Surface type.
h. Discharge Pipe Centerline Elevation: 1171.25.
i. Pump Base Elevation: 1169.75.
j. Bottom of Pump Bowl and Intake Screen Assembly Elevation: 1062.00.
k. Minimum NPSHA: 35 FT.

2. Collector Well Pumps, CWP-01, CWP-02, CWP-03 to be capable of meeting the following future conditions with replacement of only the motors:
   a. Primary design condition: 5,600 gpm at 182 FT TDH, with minimum 86 percent bowl efficiency at maximum speed.
   b. Secondary design conditions:
      1) 5,600 gpm at 73 FT TDH.
      2) 2,000 gpm at 141 FT TDH.
      3) 2,000 gpm at 60 FT TDH.
   c. Maximum motor speed: 1,800 rpm (Variable Frequency Drive).
   d. Drive motor: 350 HP (Maximum).
   e. Minimum shutoff head at 100 percent Speed: 280 FT.
   f. Discharge/Column Size: 16 IN.
   g. Bottom of Pump Bowl and Intake Screen Assembly Elevation: 1062.00.
   h. Minimum NPSHA: 16 FT.

B. Provide pumps with increasing head characteristics from secondary design conditions to shutoff condition. Provide pumps with net positive suction head requirements (NPSHR) less than the net positive suction head available (NPSHA) at all operating conditions.

2.3 ACCESSORIES

A. See Section 11005 and Section 13440.

2.4 COMPONENTS

A. General:
1. Furnish units consisting of a vertical shaft turbine, direct connected to a vertical solid shaft motor. Design unit with non-reversing ratchets.
2. Pump manufacturer is to be responsible for the complete pump including bowl assembly, column pipe, lineshaft, bearings, discharge head, motor, and all other components.
3. Weight of revolving parts of pump including unbalanced hydraulic thrust of impeller is carried by thrust bearing in driver.
4. Make provision at driver shaft for adjusting impeller with reference to bowls.
5. Pumps to be water lubricated and must comply in all respects with the applicable regulations of the South Dakota Department of Natural Resources (SD DENR).
6. Pumps to be capable of handling reverse flow without loosening of the impeller or causing impeller damage.
7. All materials of construction shall adhere to the 2014 EPA standards for lead free.

B. Column:
1. Construct discharge column pipe of carbon steel meeting the requirements of ASTM A283, Grade B or C; or ASTM A53, Grade A, B, E, or F. Supply column pipe with flanged connections.
2. Provide top and bottom sections of column pipes to 5 FT lengths.
3. Provide intermediate column sections not exceeding 10 FT in length.
4. Column pipe to be designed and hydrostatically tested for 150 percent of the pump shutoff pressure.

5. Sandblast column and coat with a minimum 15 mils dry film thickness epoxy system at the factory.
6. Provide epoxy coating recommended by Tnemec or Carboline and must be NSF 61 approved for use with potable water.
7. The column bolting shall be 304 or 316 stainless steel.

C. Open Line Shaft:
1. ASTM A743, Grade CF-8M, or ASTM A276, Type 410 or 416 stainless steel, rolled and ground over full length.
2. The shaft diameter and spacing of bearing shall be designed to be non-vibrating when operating at the rated pump speed. Calculate the minimum shaft diameter using the formulas given in Subsection A4.3.3 of AWWA E101-88 (ANSI B58.1), for the pump shutoff head and/or maximum horsepower, whichever is greater.
3. Provide pump column shaft in lengths equal to the column pipe lengths. Maximum 10 FT length. The pump manufacturer to perform a critical speed analysis to determine bearing spacing.
4. Key and thrust-ring or other non-threaded type shaft coupling for shaft diameters 2 IN and larger. Type 316 stainless steel thrust rings, cap screws, and keys to be used. Threaded couplings may be used of shaft diameters 1-15/16 IN and smaller. Provide one-piece bowl shaft. No bowl shaft coupling will be allowed.
5. Provide Vesconite bearings at each column connection suitable for dry running during the startup period of the pump. Bearings to be supported by retainers butted between machined faces of discharge column.
6. Provide a line shaft prelubrication system, adequately sized, to water lubricate the line shaft bearings prior to pump startup. The pump discharge head shall be provided with a connection for the prelubrication system.

D. Pump Bowl and Suction Bell:
1. Provide bowl and suction bell constructed of close grained cast iron, free from imperfections and accurately machined and fitted.
2. The bowls are to be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or 150 percent of the shut off head, whichever is greater.
3. Each bowl to be fitted with water lubricated dual bearing design consisting of both bronze and rubber sleeve type bearings to reduce abrasive wear in the bearing area.
4. Intermediate bowl to have sand lugs cast into the top flange to reduce the wear from abrasives on the pump bowl.
5. Bronze sleeve type bearing at the top and bottom of each stage.
6. Coat pump bowl water passages with an abrasion-resistant baked enamel, phenolic or epoxy.
7. Provide NSF 61 approved epoxy coating on the inside and outside of the bowl and suction bell suitable for potable water service.
8. Provide bowls with renewable wear rings adjacent to the impeller. Bowl and impeller wear rings to be stainless steel ASTM A743, Grade CF-8M or CA8M or CA-15; or ASTM A276, Type 410, with Brinell hardness difference of 50.
9. Design to ensure easy removal of bearings and impeller.
10. Furnish suction bell with flared end to reduce entrance losses and with a sufficient number of vanes to support lower guide bearings and weight of impeller and pump shaft when dismantling pump.
11. The bowl bolting to be 304or 316 stainless steel.

E. Bearings:
1. Provide units with sleeve bearings of SAE 600 bronze, lead free, in each bowl and in suction bell.
2. In bowl, provide main bronze bearing immediately above impeller and a lower bronze bearing immediately below impeller.
3. Provide for lubrication of bowl bearings with pumped liquid.
4. Furnish suction bell bearing having minimum length equal to five (5) shaft diameters.

5. Ensure bell bearing is permanently packed type with packing to be a nonsoluble grease.
6. Provide SAE 40 bronze collar for bell bearing to prevent abrasives from entering bearing.

F. Pump Shaft and Impeller:
1. Provide pump unit shaft constructed of rolled and ground 416 or 410 stainless steel.
2. Furnish one-piece enclosed type impellers constructed of bronze, ASTM B584 or stainless steel A276, Type 316 and securely attached to impeller shaft with stainless steel tapered collets.
3. Ensure impeller is accurately fitted and statically and dynamically balanced.

G. Discharge Head Assemblies:
1. Design discharge head assembly for 150 psi working pressure and 250 psi test pressure.
2. Provide discharge head for above ground mounting constructed of fabricated steel with integral discharge flange.
3. Construct discharge nozzle with a vertical vane to minimize turbulence.
4. Furnish ASME B16.1, 125/150 LB flange.
5. Supply the discharge head with lifting lugs capable of supporting weight of entire unit.
6. Weld flange to the discharge nozzle at specified elevation.
7. The discharge head shall be fitted with a flanged adjustable spacer coupling to allow for easy removal of the mechanical seal without disturbing the motor.
8. The interior of the discharge head shall be coated with an NSF approved epoxy coating. The outside of the discharge head shall be primed to allow for finish coating by the Contractor.

H. Mechanical Seal:
1. Provide a mechanical seal suitable for use in non-potable water.
2. The mechanical seal metal parts shall be Type 316 stainless steel. Seal rotating and stationary parts shall be tungsten carbide on carbon face or silicone carbide on carbon face. Mechanical seal nuts and bolts, gland bolts, and nuts to be fabricated of stainless steel, type 316. Mechanical seal housing to be cast iron ASTM A48, Class 30.
3. Design seal housing to provide space and clearance for a single inside cartridge-type mechanical seal.
4. Provide a seal water flushing system through copper tubing placed from flush port orifice on the mechanical seal back to the well caisson. Provide seal water flushing system with needle valve and flow indicator device. Utilize dielectric unions where necessary. See Section 11060 for additional seal water station requirements.
5. Mechanical seals shall be John Crane, Model No. 8B1, John Crane, Model 5610, or Chesterton Model No. 155 or engineer approved equal.

I. Suction Strainer:
1. Supply basket type strainer constructed of 316 stainless steel with net open area of not less than four times the throat area of the suction bell.
2. Maximum opening shall not be more than 75 percent of the minimum opening of the water passage through the bowls and impellers.

J. Data Plates:
1. Provide stainless steel data plate securely attached to pump.
2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.

K. Motors:
1. Inverter duty rated for VFD operation, vertical solid shaft, squirrel cage, induction type.
2. 460 V, 60 HZ, 3 PH.
3. WP-I type with 1.15 service factor.
4. Size motor to drive pump continuously over the complete head - capacity range without the load exceeding the nameplate rating.
5. Design motor for 40 DegC ambient.
6. Comply with Section 11005.

2.5 MAINTENANCE MATERIALS

A. Extra Materials: Furnish the Owner the following extra parts for each individual pump (3 sets total):
   1. Impeller.
   2. Flanged Column Rubber Bearings.
   3. Bowl SS Bolting.
   4. Flange Column SST Bolt.
   5. One (1) set of wear rings.
   6. One (1) set of bowl bearings.
   7. One (1) set of line shaft bearings.
   8. One (1) mechanical seal and gland (only provide one spare seals for similar pumps).
   9. One (1) set of shaft couplings.
   10. One (1) Stainless steel collet
   11. One (1) gallon of each type of lubricant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FACTORY TESTS

A. Each pump bowl assembly shall be factory performance testing in accordance with Section 11060, with curve approval by the Engineer, prior to shipment.

B. The pump bowl assembly is to be hydrostatically tested in the factory in accordance with Section 11060.

3.3 FIELD QUALITY CONTROL

A. See Section 11005.

B. See Section 11060.

C. Field Tests: Each pump shall be field tested on water for vibration, capacity/head, full load amperage, and voltage.
   1. Field test all pumps to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating in accordance with Section 11005.
   2. Contractor shall provide an acceptable testing agency specialized in the field of baseline vibration testing and machinery condition diagnosis on all rotating equipment, including drivers in accordance with Section 11005.
   3. All field testing shall be conducted in the presence of the Owner and/or Engineer.
   4. Manufacturer’s representative shall be present for all field testing of pumps. Provide on-site services as indicated in Section 11060. In addition it shall be the responsibility of the pump manufacturer to perform pump tests utilizing the variable frequency drive unit, pump, and motor combinations. The manufacturer shall supply all equipment for conducting the flow testing. If measured flows corresponding to the given pump heads are more then 5 percent below the flows provided in the factory test, adjustment to the impeller is needed. Alternatively, provide new impellers or rework the pumps.
      a. On-site pump testing shall show a minimum of five (5) operating points along the curve while running at maximum specified pump speed including efficiency for each point, operating point at peak efficiency, and pump run-out points.
         1) Operation points shall include the design condition for each pump and for flow conditions approximately 10 percent above this flow condition and 10 percent below this flow condition.
         2) Pumps shall be operated at each selected point for a duration of not less than one (1) HR each and shall be operated at the design point for a minimum of six (6) HRS.

3) Water used for on-site testing shall be well water from the collector well caisson.

b. Pump curve tests shall be conducted on site for each pump while operating at 70 percent of specified pump speed and shall include pump efficiency for each point, operating point at peak efficiency, shut-off head, and pump run-out point.

END OF SECTION

2014/08/28

SECTION 11077
PUMPING EQUIPMENT: INLINE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Inline centrifugal pumps.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 11060 - Pumping Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   3. Hydraulic Institute (HI):
      a. Standards for Centrifugal, Rotary and Reciprocating Pumps.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 11060.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Inline centrifugal pumps:
      a. Taco.
      b. Bell & Gossett.
      c. Gould.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Pump Service Category and Tag Number:
   1. Pump casing: Cast iron, ASTM A48, Class 30.

2. Impellers: Bronze, ASTM B584 (836).
3. Shaft: Carbon steel.
4. Impeller wear rings: Bronze, ASTM B584 (836).
5. Shaft sleeve: Bronze, ASTM B584 (831).

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Pump service category and tag number: P-01
      a. Design condition: 90 gpm at 61 FT TDH with minimum pump efficiency of 50 percent.
      b. Shutoff condition: 0 gpm at 61 FT TDH.
      c. Pump configuration: In-line.
      d. Maximum pump speed: 1760 rpm.
      e. Nameplate driver horsepower: 3.0.
      f. Drive type: Constant speed.
      g. Drive configuration: Direct coupled.
      h. Net Positive Suction Head Required (NPSHR): 2.5 FT.
   2. Pump service category and tag number: P-02
      a. Design condition: 65 gpm at 28 FT TDH with minimum pump efficiency of 50 percent.
      b. Shutoff condition: 0 gpm at 37 FT TDH.
      c. Pump configuration: In-line.
      d. Maximum pump speed: 1760 rpm.
      e. Nameplate driver horsepower: 1.0.
      f. Drive type: Constant speed.
      g. Drive configuration: Direct coupled.
      h. Net Positive Suction Head Required (NPSHR): 5 FT.

2.4 ACCESSORIES

A. See Section 11060.

2.5 FABRICATION

A. Fabricate pump case to withstand 175 psig or 200 percent of maximum working pressure specified by pump performance, whichever is greater.

B. Furnish anti-friction type bearings rated for minimum ABMA L-10 life of 20,000 HRS at 24 HR continuous operation.

C. Provide grease lubrication.

D. Furnish rigid, one piece cast bearing housing with catch reservoir.

E. Provide pump case with case rings at impeller skirt. Lock ring in place with pin.

F. Statically and dynamically balance impellers per HI standards.

G. Key impeller to driven shafts and secure impeller to shaft with stainless steel locking screw.

2.6 SOURCE QUALITY CONTROL

A. Factory test one pump of each service category.

2.7 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Furnish the Owner the following extra parts for each pump service category:
      a. Shaft sleeve: One set.
      b. Shaft O-rings: One set.
      c. Bearings: One set.

d. Wear rings: Two each.
e. Gaskets: One set.
f. Set seals: One set.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

1

DIVISION 13

SPECIAL CONSTRUCTION

2014/08/28

SECTION 13200
HORIZONTAL COLLECTOR WELL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Construction of a horizontal collector well, which includes design and construction of caisson, lateral projections, lateral development, and performance testing. The location of the caisson shall be as indicated on the Drawings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. The requirements specified herein shall be considered the minimum requirements for construction of the well.
   1. The Contractor shall be responsible for satisfying any State regulations otherwise exceeding these specifications. The Contractor shall possess a well driller's license as required by the South Dakota Department of Environment and Natural Resources.
   2. The Contractor shall employ certified welders for each material to be welded.
   3. The Contractor shall employ a qualified geotechnical engineer to provide any necessary soil investigations and geotechnical recommendations required for the Contractor to complete the design and construction of the caisson.

B. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
   2. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
      a. B1.20.1, Pipe Threads, General Purpose (Inch).
      b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
      c. B31.1, Power Piping.
   3. ASTM International (ASTM):
      a. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      b. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
      c. D5716, Standard Test Method for Measuring the Rate of Well Discharge by Circular Orifice Weir.
   4. Building Code:
      a. International Code Conference (ICC):
         1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.
   5. American Society of Civil Engineers(ASCE):
      a. ASCE 7-05, Minimum Design Loads for Buildings and Other Structures.
   6. American Concrete Institute (ACI):
      a. ACI 350-06, Code Requirements for Environmental Engineering Concrete Structures.

C. Qualifications:
   1. Structural Engineer for Collector Well: Professional Engineer licensed in the State of South Dakota at the time of shop drawing submittal.
      a. Engineer to have minimum five (5) years experience in design of collector wells in scope similar to this Project.
   2. Welding operators and processes to be qualified in accordance with:
      a. AWS D1.1 for welding steel shapes and plates.
      b. AWS D1.4 for welding reinforcing bars.
   3. Contractor shall comply with and be responsible to adhere to the terms and conditions of the Owner-supplied general permit for temporary dewatering and temporary water use permit.

1.3 SYSTEM DESCRIPTION

A. The work shall include the installation of a horizontal collector well with an expected capacity ranging from 12 million gallons per day (MGD) (8,350 gallons per minute (gpm)) to 20 MGD (13,900 gpm), depending on water temperature and river level. Lateral screens shall be radially projected from within the caisson through a port assembly and terminated within the caisson with a gate valve.

B. Grade elevation at the site is as shown on the Drawings. Static groundwater level typically varies and the site is located within the floodplain of the Missouri River and as such is subject to flooding.

C. Provide all equipment, personnel, materials, and services to satisfactorily complete this work in accordance with these specifications. All materials utilized shall be new unless otherwise specifically provided for in the specifications. All workmanship and materials shall meet or exceed the industry standards usually applied to such work.

1.4 SUBMITTALS

A. Complete drawings and specifications covering materials to be furnished, and dimensions, sizes, and thicknesses of members shall be submitted in accordance with the submittals section. Additional items to be furnished shall include:
   1. Method of measuring and controlling plumbness during the sinking of the caisson.
   2. Details pertaining to the lateral installation, including lateral pipe, slotting, packer, digging head, seals, valves, and other items necessary to indicate the proposed Work.
   3. Shop drawings of all penetrations, ports, and hatches.
   4. Reinforcing shop drawing.
   5. Current certificates for each welder to be employed on the project.
   6. Complete details of lateral pipe welding.
   7. Performance testing plan, including pumping capacities of the temporary pumps to be utilized for the utilized during the performance testing.
   8. Erosion control plan.
   9. Excavation spoil and dewatering water disposal plan.
   10. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions.
   11. Concrete mix designs in accordance with Section 03308 and 03350.
      a. Manufacturer and type of proposed admixtures.
      b. Certification that the fly ash meets the quality requirements stated in this Specification Section, and fly ash supplier's certified test reports for each shipment of fly ash delivered to concrete supplier, if fly ash is used.
   12. Well lateral development documentation:
      a. Development procedures and duration of development.
      b. Sediment removal and sand production testing.
   13. Post well performance testing data to include:
      a. Pumping rate measurements.
      b. Water level measurements.

c. Pressure transducer data in electronic format.
d. Individual lateral flow rate testing.
e. Results of sand content testing.

14. Calculations:
    a. Provide calculations for caisson and all structural components and connections of collector well.
    b. Calculations shall include coordination of pump station to be placed upon collector well. Connections shall match pump station elements shown on the Drawings.
    c. Calculations will not be reviewed and are submitted for record purposes only.
    d. Calculations shall be unique for this project and consider specific depths, diameters, connections, and loading as described herein and on the Drawings.
    e. Calculations shall be sealed by a Registered Civil or Structural Engineer in the State of South Dakota.
    f. Include any geotechnical reports and investigations developed or used for this design.

1.5 DEFINITIONS

A. Collector Well: Entire system of concrete caisson, horizontal laterals, and associated components as described in this section.

B. Caisson: Structural concrete component of the Collector Well.

C. Laterals: Piping component that extends laterally from the base of the Caisson.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete and Reinforcement: As specified in Division 3.
    1. Minimum Concrete Strength: F'c = 4000 psi.

B. Concrete Accessories including but not limited to waterstops, reinforcing chairs, and formwork: As specified in Division 3.

C. Stainless Steel Pipe: Schedule 40S.

D. Lateral Pipe: ASTM A312 or ASTM A778, Grade TP304L.

E. Fittings: As specified in Section 15060.

F. Backing Flanges: AISI Type 304 stainless steel plate, with ANSI/ASME B16.5, Class 150 diameter and drilling; bolt holes shall be enlarged to accept bolt insulating sleeves; with the following thickness:

Nominal Pipe Size (IN)	Flange Thickness (IN)
1/2 - 8	1/2
10 – 14	5/8
16 – 18	3/4
20 – 30	1

G. Flange Bolts and Nuts: As specified in Section 15060.

H. Insulated Flanges:
    1. Gaskets: PSI "Linebacker, Type E", full faced, insulating and sealing flange gasket. 1/8 IN thick Pyrox G-10 glass reinforced epoxy retainer with teflon quad-ring seal. Inside diameter shall be 1/8 IN less than inside diameter of flange.
    2. Sleeves: Pyrox G-10 insulated sleeve, 1/32 IN thick, for each flange bolt.

3. Washers:
    a. Insulating: Two flat Pyrox G-10 insulating washers, 1/8 IN thick, for each flange bolt.
    b. Metal: Two (2) flat AISI Type 304 stainless steel washers, 1/8 IN thick, for each flange bolt. OD shall not be larger than OD of insulating washer.
    c. Primer: Tapecoat "TC Coldprime".

I. Lateral Screens: Type 304 Stainless Steel, wire wrapped.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The horizontal collector well shall be designed for the following minimum operating conditions and requirements unless otherwise noted.

Anticipated Minimum Capacity	12.0 MGD
Anticipated Maximum Capacity	20 MGD
Minimum Inside Caisson Diameter	16 FT
Minimum Outside Caisson Diameter	19 FT
Minimum Number of Laterals	13
Number of Lateral Tiers	2
Caisson shoe elevation	1048.00 FT Elevation
Caisson floor elevation	1052.00 FT Elevation
Centerline of Lower Laterals	1055.00 FT Elevation
Centerline of Upper Laterals	1059.00 FT Elevation
Min Concrete Bottom Plug Thickness	4 FT
Min Number of Ports	15
Estimated Effective Length	185 FT per lateral
Min Lateral Diameter	10 IN
Max Screen Entrance Velocity	2 FT/min (50% blockage) at 20 MGD
Max Lateral In-Line Velocity	5 FT/Sec

B. The horizontal collector well caisson shall be designed to meet the following minimum structural requirements:
    1. Assumed wall thickness is shown on Drawings. If different wall thickness is desired contact Engineer for resolution prior to installation. Contractor shall coordinate all pump station dimensions with caisson wall thickness and vertical alignment.
    2. Contractor to establish end bearing and skin friction values as required for design and construction.
    3. Caisson shaft shall be designed according to requirements of ACI 350.
        a. Design for loading indicated on the Drawings.
        b. Use requirements of ASCE 7 as referenced by the Building Code to develop caisson loads acting in addition to the pump station loads shown on the Drawings.
        c. Use load combinations in ACI 350 to obtain required strength.
        d. Design for groundwater level as follows:
            1) Minimum water level at lowest drawdown elevation
            2) Maximum water level at 500 year flood elevation shown on Drawings.
            3) Bottom plug shall be designed as required for construction and to resist hydrostatic pressure with an empty caisson and maximum design groundwater.
            4) Design entire caisson system to resist flotation in its completed state.
        e. Design to resist flotation of caisson during construction. If external restraint or flooding of caisson is required to resist flotation after completion of the plug but prior to project completion, show critical water levels on shop drawings.
        f. Design caisson to resist loads that may be encountered during construction, including point and unbalanced pressure loads on caisson cutting edge, restraint loads from a deadman or other driving aids, and tension loads from loss of vertical support in lower caisson during driving.
    4. Design caisson for pipe penetrations and structural connections shown on Drawings.

2.3 WALL PORTS

A. The ports for the well laterals shall be fabricated of Type 304 stainless steel. The flanges shall be threaded for standard studs. Port assemblies shall be in accordance with the Contractor's design and shall be submitted to the Engineer for approval. Unused ports shall be furnished with blind flanges.

2.4 LATERAL PIPE

A. Lateral pipe shall be stainless steel as indicated in the materials list.
   1. Threaded Joints:
      a. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads.
   2. Flanged Joints:
      a. Flanged joints between cast-iron valves and stainless steel flanges shall use insulated flange kits as specified in the materials section. Insulated flange kits shall be installed in accordance with the manufacturer's recommendations. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.
      b. Welded Joints:
         1) Welding shall conform to the specifications and recommendations in the "Code for Pressure Piping", ANSI B31.1.

2.5 SCREEN

A. Screens shall be of continuous slot, wire-wound construction, as manufactured by Johnson, or approved equal, with flush joint connections and have a minimum diameter as specified in Paragraph 2.2.A. Screens shall be sized to provide the specified well capacity in accordance with the manufacturer's design, pipe-size type, with flush joint connections. Screens shall be adequate to provide the specified capacities with an average entrance velocity through the screen openings of 2.0 FT per minute or less assuming a screen blockage of 50 percent. The number, length and orientation of the lateral screens are as shown on the drawings. The intent of the specifications is to have thirteen 185 FT laterals, each equipped with 175 FT of screen. The slot openings of the lateral screens shall be determined by the Contractor to produce the specified yield and meet the sand production limits as specified in Article 3.3. Actual screen slot sizes shall be determined based upon selected sieve analyses of samples collected at 5 FT intervals during lateral pipe projection and subject to the approval of the Engineer prior to installation. Screen collapse strength shall include a safety factor of 2 times the ground/loading pressure across the entire range of anticipated slot sizes. Screen projection pipe shall be sized to install the screen. If filter pack is used, screen slots shall be sized to retain 90 percent or more of the filter pack. Pipe shall be of sufficient strength to withstand the stresses of projection into and withdrawal from the aquifer.

2.6 FILTER PACK

A. Provide filter pack material consisting of clean well rounded grains that are smooth and uniform. The material shall be ceramic or glass beads, or siliceous natural aggregate with a limit of 5 percent by weight of calcareous material.

B. Provide filter pack consisting of hard, rounded grains with an average specific gravity of not less than 2.5. Not more than 1 percent by weight of the material shall have a specific gravity of 2.25 or less.

C. Provide filter material containing not more than 2 percent by weight of thin, flat or elongated pieces and free of shale, mica, clay, sand, dirt, loam, and organic impurities and containing no iron or manganese in a form which will adversely affect water quality.

D. Gradation: Contractor shall select gravel pack gradation subject to review by Engineer. The acceptable filter pack envelope for the lateral screens will be based on the results of the grain size distribution analysis performed on samples collected during jacking of the blank projection pipe.
   1. A multiplier range of 3 to 6 times the d30 (cumulative percent passing) of the finest sample within the screened interval of each production well is acceptable for the filter pack.
   2. Engineer will supply sieve analysis from formation samples collected during test drilling at production well locations.
   3. The recommended filter pack should have a uniformity coefficient of < 2.5.

PART 3 - EXECUTION

3.1 CAISSON CONSTRUCTION

A. The caisson shall be constructed in lifts by the open caisson method.
   1. The deviation from plumb shall not exceed 15 IN in 100 FT.
      a. Any correction of caisson deviation, and any construction and associated costs resulting from relocation of appurtenances inside the caisson, including but not limited to pumps, motors, power supply, piping, controls, valves, valve stems, etc., caused deviation of the caisson from vertical shall be at the Contractor's expense.
   2. Final caisson lift shall be formed vertical.
   3. Terminate the top of the caisson at the elevation shown on the plans. The top of the caisson shall be finished flush within ±0.25 FT of the finished elevation.
   4. At each concrete lift or construction joint, provide 6 IN PVC continuous waterstop across joint.

B. At the option of the Contractor, a dead man and hydraulic ram system may be used to pull the caisson in to the ground.

C. If a concrete dead man is cast around the caisson, top of concrete for this dead man must be at or below elevation 1158.00 FT MSL at the completion of caisson construction. Contractor shall remove all portions of the deadman that interfere with site piping, electrical conduit, grounding, or other utilites. When the cutting edge of the caisson has been sunk to at least 1048.00 FT MSL, and the top of the caisson is at the final elevation, the Contractor shall clean the cutting shoe bevel area and place plug concrete by tremie. After the plug has attained design compressive strength, the Contractor shall dewater the caisson and remove all loose material to a sound surface. Place a concrete floor surface with a wood float finish.

D. The interior of the caisson shall be cleaned of all debris, materials, and equipment and left washed clean prior to performance testing.

E. Within 4 weeks of final completion, review grading around the caisson for any low spots or areas of improper drainage away from the structure. Make final finish grading corrections as required.

3.2 SCREEN INSTALLATION

A. Lateral screens shall be installed at an elevation and in the orientation as shown on the drawings. Installation of lateral screens shall proceed initially by jacking blank projection pipe into the aquifer radially from the central caisson to the required distance from the caisson wall or to refusal or an indication of excessive jacking pressure. After the blank pipe has been projected, lateral screens shall be inserted into the projection pipe, and then the projection pipe shall be withdrawn. Each line of lateral screen shall be completed with 10 FT of blank pipe extending from the inside wall of the caisson. The blank pipe shall conform to the requirements specified for stainless steel lateral pipe. Any lateral terminated less than 50 FT from the interior caisson wall will be considered ineffective and shall be closed with a blind flange and abandoned; its length shall not be counted in computing the total aggregate screen length required to be installed to meet contract requirements.

B. Each lateral shall be installed horizontally in a straight radial line throughout its full length. Deviation of more than one foot from horizontal shall be immediately called to the attention of the Engineer, and deviation of more than 1 foot vertically in 100 horizontal feet is unacceptable. The Contractor shall provide during projection suitable means to effect removal of aquifer material equal to the minimum of the volume of the pipe projected. At the conclusion of lateral installation, all installation equipment and appurtenances shall be removed from the interior of the screen pipe and the control valve shall be affixed to the interior end and shall be closed to await development.

3.3 LATERAL DEVELOPMENT

A. Each lateral screen shall be developed by hydraulically isolating the screen in sections not to exceed 6 FT in length. Development shall be by jetting, compressed air, flushing, or by a combination of these methods. Alternative methods may be utilized, subject to review and acceptance by the Engineer. Development shall be continued until one of the following conditions can be demonstrated, and each line shall be tested individually.
   1. Sand production from each screen line is less than 3 ppm at a flow rate equivalent to at least 1.2 times the desired design rate times the total length of that line.
   2. Maximum sand production from all screen lines shall be less than 2 ppm during pumping of the collector well at a discharge rate of 20 MGD.
   3. Sand production from each isolated section of the screen has reached stability and cannot be improved by further development.

B. To demonstrate compliance with the above conditions, sand production shall be measured by a centrifugal sand separating device or Rossum Sand Tester attached to the discharge line, and flow rates shall be measured using either a flow meter or free discharge orifice as discussed in Article 3.4. The Contractor shall furnish all required test equipment. The Engineer shall be the final judge of whether or not development of the well has attained these objectives, and is, therefore, complete.

C. Water produced during development pumping shall remain on-site and appropriate erosion/sedimentation control measures, which may include straw bales and filter fencing, will be employed to prevent the discharge of sediment to the Missouri River. After sediment separation, water may be discharged to the Missouri River

3.4 PERFORMANCE TESTING

A. After development of the horizontal collector well, pumping tests shall be conducted to determine its installed capacity. A multiple step drawdown pumping test shall be conducted to determine the efficiency and optimum rate of pumping for the well; a constant rate method pumping test shall be conducted to evaluate impact on the surrounding area and to confirm capacity.

B. The Contractor shall be required to pump the wells during the tests for the full-specified period without shutdown. Water level measurements shall be made in the horizontal collector well, in existing Observation Wells (OW) Nos. OW-1-13, OW- 3-13, OW-2-13, OW-75P, and OW-60R, and a river stilling well during the test at intervals and in the manner directed by the Engineer.

C. After drawdown has substantially stabilized, the Contractor shall measure the velocity of the flow and water temperature from each lateral using remote measuring equipment. The Contractor shall furnish all necessary equipment to conduct the specified pump tests. All measurements of drawdown shall be made with an electric tapeline, or automated measuring device and shall be accurate within ±0.01 FT. Power to drive the pumps at the site will be furnished by the Contractor. The Contractor shall be responsible for providing power to all equipment for the pump tests.

D. Flow shall be measured using standard free-discharging circular pipe orifices. The orifices shall be constructed and operated in accordance with ASTM D5716. If multiple discharge pipes are used, the Contractor shall monitor flow on each discharge. The discharge pipe must extend a distance of at least 10 pipe diameters back of the orifice plate. Exactly 24 IN from the orifice plate, or 3 pipe diameters, whichever is greater, the pipe wall shall be tapped midway between the top and bottom with a 1/8 or 1/4 IN hole. No burrs shall be inside the pipe. The tap shall be fitted with a nipple that does not protrude inside the pipe. The nipple shall be fitted with a transparent flexible tube attached to an accurate scale set to measure the pressure head above the centerline of the pipe. If multiple discharge pipes are required, the Contractor shall monitor flow on each discharge.

E. The Owner intends to conduct water quality testing throughout the project. The Contractor shall provide sampling ports on discharge piping and assist the Owner in obtaining water samples as required.

F. During development of the well and during the period of final testing of the well, the Contractor shall be required to discharge the water to the Missouri River. The Engineer will assist Owner in obtaining discharge permit. The method of discharge shall be in accordance with all applicable rules and regulations and shall be acceptable to the Engineer. The Contractor shall furnish all labor, materials, and equipment for constructing temporary pipelines.

1. Stepped-Rate Drawdown Pumping Test:
   a. Following completion of the well, the well shall be allowed to recover for at least 48 HRS before the stepped-rate drawdown pumping test is started. The stepped-rate drawdown pumping test period shall be 8 HRS pumping and 2 HRS recovery time. To confirm compliance with specified sand content requirements (2 ppm or less), a sand test as specified in Article 3.3 shall be conducted at the end of each step. If the average of these four tests is greater than 2.0 ppm, additional development will be required.
   b. The stepped-rate drawdown test shall be an increasing rate type pumping test in which pumping rates shall be as follows:

Step	Rate	Period
1	3500 gpm	2 hours
2	8300 gpm	2 hours
3	11,100 gpm	2 hours
4	13,900 gpm	2 hours

   c. During each step of the stepped-rate drawdown test, water levels will be measured at the following frequencies (at a minimum) at the following monitoring points. Water levels at all of the measurements points shall be collected using an electronic water meter prior to initiating the stepped-rate test and at the end of the recovery period. Measurements collected using electronic water meters will be recorded on standardized data forms.
      1) Collector Well:
         a) Every 1 minute for the first 15 minutes from the start of each step;

b) Every 5 minutes for 15 to 60 minutes from the start of the step;
c) Every 10 minutes for 60 to 120 minutes from the start of the step;

2) Observations Wells (with transducers provided by Contractor):
a) Every 5 minutes throughout the testing period.

3) River (stilling well):
a) Every 10 minutes throughout testing period.

d. The pumping rate shall also be measured and recorded to every 10 minutes. Following the shut down of the pump, water levels measurements will be collected at the same frequency noted above for 2 HRS. Optimum rate of pumping for the Collector Well shall be determined by Contractor in consultation with the Engineer from the results of the step drawdown test.

e. Sand content testing:

1) The sand content shall be determined by collecting well samples at the following times during the final step of the Stepped-Rate Drawdown Pumping Test:
a) 1 minute after the start of the test.
b) 5 minutes after the start of the test.
c) 10 minutest after the start of the test.
d) 15 minutes after start of the test.
e) 20 minutes after start of the test.
f) 25 minutes after start of the test.
g) After 1/4 of the total planned test time has elapsed.
h) After 1/2 of the time has elapsed.
i) After 3/4 of the time has elapsed.
j) Near the end of the pumping test.

2) The maximum acceptable sand content shall be 3 mg/l from any one measurement. The maximum average sand content for the time intervals specified above shall be 2 mg/l or less. every sample without exception.

3) Sand content shall be determined by using a Rossum testing apparatus as available from Roscoe Moss Company, Los Angeles, California, or equivalent.

2. Constant Rate Test:

a. Following the stepped-rate method pumping test, the well shall be allowed to recover for at least 16 HRS before the constant rate method pumping test is started. The constant rate method pumping test period shall be 72 HRS pumping time and 24 HRS recovery time. To confirm compliance with specified sand content requirements (2 ppm or less), a sand test as specified in Article 3.3 shall be conducted at elapsed times of 1 HR, 24 HRS and 48 HRS during the constant rate test. If the average of these three tests is greater than 2.0 ppm, additional development will be required. The optimum rate of pumping determined by the Contractor in consultation with the Engineer from the step drawdown test shall be used for the constant rate pumping test.

b. During the test, discharge from the pumping well will be maintained at a constant rate (within 5%), with flow monitored by the metering equipment specified. The pumping rate will be 20 MGD and based upon the results from the variable (stepped) rate pumping test. At the conclusion of the test, the pump will be shut off and the recovery of water levels monitored for 24 hours. Water levels at all of the measurements points shall be collected using an electronic water meter prior to initiating the constant rate test, minimally daily during the constant rate test, prior to the end of the pumping portion of the test, and at the end of the recovery period. During the constant rate test, water levels measurements will be collected at the following frequencies at the following monitoring points, and measurements obtained using electronic water meters will be recorded on standardized data forms.

1) Collector Well:
a) Every 1 minute for the first 15 minutes from the start of the test;
b) Every 5 minutes for 15 to 60 minutes from the start of the test;
c) Every 10 minutes for 60 to 120 minutes from the start of the test;
d) Every 20 minutes for 120 to 180 minutes from the start of the test;
e) Every 30 minutes for 180 to 300 minutes from the start of the test;

f) Every 60 minutes for 300 to 4320 minutes from the start of the test;

2) Observation Wells (with transducers provided by Contractor):
   a) Every 1 minute for 1 to 10 minutes from the start of the test;
   b) Every 5 minutes for 10 to 60 minutes from the start of the test;
   c) Every 10 minutes for 60 to 180 minutes from the start of the test;
   d) Every 30 minutes for 180 to 600 minutes from the start of the test;
   e) Every 60 minutes for 600 to 4320 minutes from the start of the test

3) River (stilling well):
   a) Every 10 minutes throughout testing period.

c. Recovery Frequency and period shall be measured to the above drawdown schedule for a period of 24 HRS. However, if the Engineer determines that the recovery level has stabilized to the natural static water level, measurements may be discontinued. The pumping rate shall also be measured and recorded at the same frequency listed above.

3. Well efficiency:
   a. Minimum well efficiency shall be 80 percent or greater as calculated by Engineer.
   b. Engineer shall use the Cooper-Jacob Distance Drawdown Method based on the constant rate test data to calculate well efficiency.
   c. If the calculated well efficiency is below 80 percent, the Contractor shall be responsible to do the following:
      1) Redevelop and retest (variable and constant rate) the well to meet the well efficiency requirements at no additional cost to the Owner.
4. Test Report:
   a. The Contractor shall furnish to the Engineer copies of the field data, any calculations and graphs of water level plotted to logarithmic scale of the step and constant rate pump tests performed for the well.
5. Aborted Test:
   a. Failure of pump operation for a period longer than 2 percent of the elapsed pumping time shall require suspension of the test until the water level in the pumped well has recovered to within 95 percent of original level. Once the water level has recovered, the test must be restarted. Recovery shall be considered "complete" after the well has been allowed to rest for a period at least equal to the elapsed pumping time of the aborted test, except that if any three successive water level measurements spaced at least 20 minutes apart show no further rise in the water level in the pumped well, the test may be resumed immediately. The Engineer shall be the sole judge as to whether this latter condition exists.

G. Production Well Water Quality and Sampling Analysis:
1. During the constant rate test, collect water quality samples at the beginning, middle and end of the constant rate test.
   a. Samples will be collected for radiological, EPA priority pollutants and general water quality, including ammonia and TOC.
   b. Sample bottles, sample shipment and testing will be the responsibility of Contractor.
   c. Provide 24 HR notice to Engineer prior to sampling.
      1) Engineer shall witness the collection of sample, preparation of sample for shipment and be provided confirmation of shipment.

3.5 EROSION AND POLLUTION CONTROL

A. During construction and pumping tests, the Contractor shall employ techniques to prevent harmful materials, construction debris, and excessive suspended solids from entering the waterway. The Contractor shall submit his proposed methods to the Engineer for review prior to the start of well construction and shall address the following:
1. Diversion of sand, silt, and debris removed from the bottom of the caisson and pumped discharges carrying these materials, to prevent erosion and runoff of solids and debris.
2. Protection of the site from surface erosion during construction.
3. Disposal of waste construction materials, including concrete wash.

4. Disposal of other potential contaminants that would otherwise be dumped, sprayed, or placed near waterways or disposed of onsite.

3.6 CONCRETE FINISHES

A. See Section 03348 for concrete finishes exterior above grade and interior concrete finishes.

3.7 CONCRETE TESTING

A. Testing for cast in place concrete shall be in accordance with Section 03350.

END OF SECTION

1

2014/10/08

SECTION 13440

INSTRUMENTATION FOR PROCESS CONTROL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 13448 - Control Panels and Enclosures.
   5. Division 16 - Electrical.
   6. Section 16120 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Canadian Standards Association (CSA).
   2. FM Global (FM).
   3. The Instrumentation, Systems, and Automation Society (ISA):
      a. S5.1, Instrumentation Symbols and Identification.
      b. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      c. S5.4, Standard Instrument Loop Diagrams.
      d. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. National Institute of Standards and Technology (NIST).
   7. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Pre-Negotiated Pricing:
   1. The Owner has negotiated a price for procuring most of the equipment and manufacturer's services associated with Specification Sections 13440 through 13504. The pricing is listed in the Bid Form. In addition to this cost, the Contractor shall include in its Bid additional costs for unloading, storage, provision, installation, startup, demonstration, all applicable taxes and fees, and other appurtenant costs associated with the control system as required to meet all requirements of these Contract Documents.
   2. The proposal defining materials and services provided for the pricing shown in the Bid Form is attached at the end of this Specification Section. In addition, the Contractor shall include in its Bid any and all requirements of these Specification Sections that are not included in Huffman Engineering's proposal.

C. Pre-Approved Instrumentation and Control System Integrator:
   1. Design Solutions & Integration (DSI, Inc.).
      716 N Helen Ave.
      Sioux Falls, SD 57104
      (605)-330-0202

D. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.3 DEFINITIONS

A. Architecturally finished area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.

B. Non-architecturally Finished Area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.

C. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

D. Calibrate: To standardize a device so that it provides a specified response to known inputs.

1.4 SYSTEM DESCRIPTION

A. Control System Requirements:
   1. This Specification Section provides the general requirements for the instrument and control system.
   2. The instrument and control system consists of all primary elements, transmitters, switches, controllers, computers, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

C. Single Instrumentation Subcontractor:
   1. Furnish and coordinate instrumentation system through a single instrumentation subcontractor.
      a. The instrumentation subcontractor shall be responsible for functional operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of Drawings and Operation and Maintenance Manuals, start-up, training, demonstration of substantial completion and all other aspects of the control system.
   2. Ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.
   3. Prior to Shop Drawing preparation, the Instrumentation Subcontractor shall inspect the Owner's existing equipment and as-constructed electrical documentation so as to be able to fully coordinate the interface of new and existing instrumentation and controls.
   4. All costs associated with this Work shall be incorporated into the original bid.
   5. Although such Work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   3. Limit the scope of each submittal to one (1) Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 13440.
   4. Product technical data including:
      a. Equipment catalog cut sheets.
      b. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument.
      c. Materials of construction.
      d. Minimum and maximum flow ranges.
      e. Pressure loss curves.
      f. Physical limits of components including temperature and pressure limits.
      g. Size and weight.
      h. Electrical power requirements and wiring diagrams.
      i. NEMA rating of housings.
      j. Submittals shall be marked with arrows to show exact features to be provided.
   5. Comprehensive set of wiring diagrams as specified in Specification Section 13448.
   6. Panel fabrication Drawings as specified in Specification Section 13448.
   7. PLC equipment Drawings.
   8. HMI graphics.
   9. Nameplate layout Drawings.
   10. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
      a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
   11. All Shop Drawings shall be modified with as-built information/corrections.
   12. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
      a. Furnish electronic files on CD-ROM or DVD-ROM media.
      b. Drawings in AUTO CAD format.
   13. Provide a parameter setting summary sheet for each field configurable device.
   14. Certifications:
      a. Documentation verifying that calibration equipment is certified with NIST traceability.
      b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
         1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
   15. Testing reports: Source quality control reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

1.7 SITE CONDITIONS

A. Unless designated otherwise on the Drawings, area designations are as follows:
   1. Outdoor area:
      a. Wet.
      b. Corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
      c. Below grade vaults and manholes:
         1) Subject to temporary submergence when specifically designated on the Drawings or Specifications.
   2. Architecturally finished area:
      a. Dry.
      b. Noncorrosive unless designated otherwise on the Drawings or in the Specifications.
      c. Nonhazardous unless designated otherwise on the Drawings or in the Specifications.
   3. Non-architecturally finished area: As designated elsewhere on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the following:
   1. Areas designated as wet: NEMA Type 4.
   2. Areas designated as wet and/or corrosive: NEMA Type 4X.
   3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
      a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
      a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
   6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:
   1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two (2) cycles per minute or a magnitude of movement of 0.5 percent full travel.
   2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
   3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.

4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.
5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10400.

B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per Division 16.

C. Panel-Mounted Instruments:
1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

D. See Specification Section 16120.

3.2 FIELD QUALITY CONTROL

A. See Specification Section 01650.

B. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
1. Documentation requirements include the utilization of the forms located at the end of this Specification Section.
a. Loop Check-out Sheet.
b. Instrument Certification Sheet.

C. Instrumentation Calibration:
1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
2. Calibrate all field-mounted instruments, other than local pressure and temperature gages, after the device is mounted in place to assure proper installed operation.
3. Calibrate in accordance with the manufacturer's specifications.
4. Bench calibrate pressure and temperature gages.
a. Field mount gage within seven (7) days of calibration.
5. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 percent.
a. Check for both increasing and decreasing input signals to detect hysteresis.
6. Replace any instrument which cannot be properly adjusted.
7. Stroke control valves with clean dry air to verify control action, positioner settings, and solenoid functions.

8. Calibration equipment shall be certified by an independent agency with traceability to NIST.
    a. Certification shall be up-to-date.
    b. Use of equipment with expired certifications shall not be permitted.
9. Calibration equipment shall be at least three (3) times more accurate as the device being calibrated.

D. Loop check-out requirements are as follows:
1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
    a. Use actual signals where available.
    b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
        1) Verify that readings at all loop components are in agreement.
        2) Make corrections as required.
            a) Following any corrections, retest the loop as before.
2. Stroke all control valves, cylinders, drives and connecting linkages from the local OIT (Operator Interface Terminal and from the remote control room HMI (Human Machine Interface).
3. Check all interlocks to the maximum extent possible.
4. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

E. Provide verification of system assembly, power, ground, and I/O tests.

F. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

END OF SECTION

October 6, 2014

Dave Penner
HDR Engineering INC.

Re: Yankton WTP Collector Well Addition Scope Letter
DSI Quote # XXXXXX-XXXX

Design Solutions & Integration is pleased to provide the following scope letter on the controls integration of the Horizontal Collector Well for the City of Yankton WTP. Sections that we are covering are 13440. 13441, 13442, 13446, 13447, 13448, 13449, 13500, 13502 and 13504. DSI will be providing control panels, instrumentation and programming.

Below is a list of control panels to be provided:

1. One Collector Well PLC Panel
2. One Remote I/O Panel

Below is a list of instrumentation to be provided:

1. Three flow meters- (FE/FIT-01, FE/FIT-02, FE/FIT-03)
2. One Pressure Transmitter (PIT-05)
3. Three Pressure Switches (PSH-01, PSH-02, PSH-03)
4. Four Pressure Gages (PI-01, PI-02, PI-03, PI-05)
5. One Submersible Level Transmitter (LT-06)
6. Four Door Switches (ZS-50, ZS-51, ZS-52, ZS-53)

*Note- Pipe tubing, instrument valves, accessory hardware are not included and to be provided by others.

Below is a list of Telemetry equipment to be provided:

1. One MDS iNET II Radio
2. One radio antenna and cables
3. One antenna mast and mounting hardware

Labor Included in this quote

1. Drawings of control panels
2. UL 508A Listing
3. Panel building and factory test in shop
4. PLC Programming
5. HMI Programming
6. Startup Onsite

8135 61st NW Stanley, ND 58784 | 701.628.0303 716 N Helen Ave Sioux Falls, SD 57104 | 605.330.0202 PO Box 5300, 1211 Rylan Rd, Unit #1 Grand Forks, ND 58206 | 800.347.7340
www.ds-integration.com

DSI Quotation Number: XXXXXX-XXXX
Re: Yankton WTP Collector Well Addition Scope Letter

This quote does not include the following:

1. Installation of any kind onsite
2. Demolition of any kind onsite
3. Wiring of any kind onsite
4. Termination in control panels onsite
5. Termination of instrumentation onsite
6. Any taxes other than sales tax for DSI-furnished items

Project Total price not including taxes……$xxxxx.xx

Thanks for the opportunity and please call with any questions or concerns.

Respectfully,

Brian Pistulka
716 North Helen Ave
Sioux Falls SD, 57104
(605)330-0202 ext 203
(605)330-0203 fax
bpistulka@ds-integration.com

Payment Terms:
•Due net 30.
•Prices are firm if accepted in within 60 days.

Purchase Orders issued on the above proposal are subject to final acceptance by Design Solutions & Integration, Inc and to all of the Payment Terms listed on this proposal. Acceptance of this proposal indicates the purchaser's agreement to these Payment Terms.

Acceptance of Proposal – The preceding prices, specifications and Terms are satisfactory and hereby accepted. You are authorized to proceed.

Signature _____ Name Print/Type _____ Official Position _____ Date _____

Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 1 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
P201 Start Sig				VFD-107	21, 22	PLC Cab	103, 104
P201, Speed inp				VFD-107	27, 28	PLC Cab	67, 68, 69
P201 Start out				VFD-107	31, 32	PLC Cab	72, 73, 74
Press transmit	PIT-107	JS	--	PIT-107	+ / -	PLC Cab	98, 99, 100

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT
MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR	PI-107A	SI-107				
EQUIP STATUS	P201 ON	P201 OFF	V-107 open	V-107 close		
ALARM POINT	PAH-107					

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION
H-O-A sel sw	HS-107A	VFD-107				
L-O-R sel sw	HS-107B	@ P201				
S/S switch	HS-107C	MCC	HS-107D	MCC		

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point
PAH-107	120 psi				
SC-107		2.0	5.0	0.2	80 psi

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

(1) HS-107B in Local: (a) start/stop operation via HS-107A and HS-107C, D (b) Manual/auto operation via HS-107A. In auto, pump stopped on hi press, started on lo press. (2) HS-107B in Remote: Observed operation from PLC-pump stopped on hi press, started on lo press. (3) Observed V-107 open/close automatically in accord with pump run condition. (4) Observed all indications and terminations shown above. (5) Tuned SC-107

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith (Work Performed By) Date: 12/19/98

Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 2 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
V-107 open ZS				ZSO-107	+ / -	PLC Cab	112, 113
V-107 close ZS				ZSC-107	+ / -	PLC Cab	114, 115

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT
MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS	ZOI-107	ZCI-107				
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

Checked terminations and verified indications shown above.

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith (Work Performed By) Date: 12/19/98

(Version 2.0, May 2014)

Loop Check-out Sheet

Project Name:	Owner's Project No. (if applicable):	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____

(Work Performed By)

(Version 2.0, May 2014)

Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date: 12/19/98	
Control Loop No.:	222		
Instrument Tag No.	TSH-222	Transmitter/gauge span:	
Manufacturer:	ACE, Inc.	Switch set-point:	50 F
Model No.	TL-2983-SH5	Switch dead band:	5 F
Serial No.	10293583	Switch range:	32-200 F

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)	49.8 F	Contact Close	0.1%	45.1 F	Contact Open	0.2%
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 1.0% Switch Range

Remarks:

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Temperature (dry block) calibrator	Hart Scientific XL5897T	0.1 F	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	106		
Instrument Tag No.	PIT-106A	Transmitter/gauge span:	0-200 psi
Manufacturer:	ACE, Inc.	Switch set-point:	
Model No.	1275-X	Switch dead band:	
Serial No.	3049569TSH	Switch range:	

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%	0.00 psi	4.02 mA	0.13	0.00 psi	4.00 mA	0.00
25%	50.00 psi	8.00 mA	0.00	50.00 psi	8.01 mA	0.06
50%	100.00 psi	12.01 mA	0.06	100.00 psi	12.00 mA	0.00
75%	150.00 psi	16.00 mA	0.00	150.00 psi	16.01 mA	0.06
100%	200.00 psi	20.00 mA	0.00	200.00 psi	19.99 mA	0.06
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 0.15% span

Remarks: Adjusted zero-otherwise no adjustments required

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Pressure calibrator	Hathaway/Beta XL5946P	0.025% full scale	Yes
Pressure module	Hathaway/Beta XL5948P-6:0-150 psi	0.025% full scale	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Instrument Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____ Date Certified: _____

Final Control Element Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	056		

Tag No.	LCV-056A
Description:	Control Valve
Manufacturer:	ACE, Inc.
Model No.	XYZ-123
Serial No.	748569AP2

Actuator:	Pneumatic: X Electric:
Positioner:	Direct: X Reverse:
Positioner:	Input: 9-15 psi Output: 0-100%
I/P Converter:	Input: 4-20 mA Output: 3-15 psi
Valve to	Open on air failure
Valve to	Open on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%	4.00 mA	3.01 psi	0.08	4.00 mA	3.02 psi	0.17
25%	8.00 mA	6.04 psi	0.33	8.00 mA	6.05 psi	0.42
50%	12.00 mA	9.00 psi	0.00	12.00 mA	9.01 psi	0.08
75%	16.00 mA	11.97 psi	0.25	16.00 mA	12.03 psi	0.25
100%	20.00 mA	14.99 psi	0.08	20.00 mA	14.99 psi	0.08

Specified I/P converter accuracy: 0.50% % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%	9.00 psi	0%	-	9.00 psi	0%	-
25%	10.50 psi	25%	-	10.50 psi	25%	-
50%	12.00 psi	50%	-	12.00 psi	50%	-
75%	13.50 psi	75%	-	13.50 psi	75%	-
100%	15.00 psi	100%	-	15.00 psi	100%	-

Remarks: LCV-056A is not furnished with position transmitter, so travel checks were visual.

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Multi-fct calibrator	Fluke-XL743B	0.01% Rdg + 0.015% FS	Yes
Pressure Module	Fluke-XL700POS (0-30")	0.05% FS	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Final Control Element Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	

Tag No.	
Description:	
Manufacturer:	
Model No.	
Serial No.	

Actuator:	Pneumatic: _____ Electric: _____
Positioner:	Direct: _____ Reverse: _____
Positioner:	Input: _____ Output: _____
I/P Converter:	Input: _____ Output: _____
Valve to	_____ on air failure
Valve to	_____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**
0%						
25%						
50%						
75%						
100%						

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____ Date Certified: _____

(Version 2.0, May 2014)

2014/08/28

SECTION 13441
CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Instrumentation control loops.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 QUALITY ASSURANCE

A. See Specification Section 13440.

1.3 SYSTEM DESCRIPTION

A. General Requirements:
   1. In addition to the requirements specifically stated within the control loop descriptions, all control software and hardware shall be provided as required to ensure the safe and reliable operation of all controlled equipment.
   2. A "transmitter trouble" alarm shall be generated upon the loss of each transmitter signal, or if the signal is "out-of-range" (outside the 4 to 20 mA signal).
   3. A "fail-safe" design shall be incorporated into the design such that the loss of any signal or loss of power shall not endanger personnel or result in equipment damage.
   4. All "soft" alarms on analog signal shall reside in the PLC logic with de-bounce timers. The soft setpoint shall be able to be modified through the OIT/HMI system with appropriate security.
   5. All alarm and trip time delays shall be operator adjustable from the OIT/HMI system with appropriate security.
   6. All process values, ranges, and setpoints described herein shall be considered "Initial values" and may be changed during installation and start-up.
   7. Flow signal inputs are to be totalized for each calendar day. The HMI system shall display a value for "today's total flow" (FQI-xxxx), and "yesterday's total flow" (FQIY-xxxx). Each day's total is to be stored in the HMI system for eventual printout on a monthly basis.
   8. All PID loops shall be programmed for "bumpless transfer" between the auto and manual modes from the HMI system.

B. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents.
   1. Descriptions are provided as follows:
      a. Control system overview and general description.
      b. Major equipment to be controlled.
      c. Major field mounted instruments (does not include local gages).
      d. Manual control functions.
      e. Automatic control functions/interlocks.
      f. Remote indications and alarms.

C. The Control Loop Descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the Drawings and other Specification Sections.
   1. The control loop descriptions shall not be considered equal to a bill of materials.

D. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on Drawings.

1.4 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 13440.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

D. Control Strategy for Record Documents:
   1. Obtain this Specification Section 13441 in electronic format (Microsoft Word) from Engineer at beginning of Project.
   2. Revise and update the file monthly during construction and start-up to reflect all changes that occur due to specific equipment and systems supplied on the Project.
      a. Show all revisions in 'track change' mode.
      b. Change Specification Section Title to read "Control Loop Descriptions - Contractor Record Document."
      c. Reference all changes by Request for Information (RFI) number or Change Proposal Request (CPR) number.
      d. Submit revised file monthly to Engineer for review.
   3. Deliver the revised and updated file as a final control loop description Record Document in the Operation and Maintenance Manual described in Specification Section 01342.
   4. Provide both paper copy and electronic copy (on CD-ROM) of the Record Document control loop descriptions in the Operation and Maintenance Manual described in Specification Section 01342.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 CONTROL LOOPS

A. Control Loop 01: Collector Well Pump CWP-01.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
      c. Collector Well Pump CWP-01 and associated VFD.
   2. Major Field Instruments:
      a. Pump discharge pressure switch: PSH-01.
      b. Pump discharge magnetic flow meter: FE/FIT-01.
   3. Control Logic:
      a. Control of Collector Well Pump CWP-01 is in accordance with selections made at the VFD.
         1) When LOCAL mode is selected at the VFD, the operator can manually start/stop the pump and control pump speed from the VFD.

2) When REMOTE mode is selected at the VFD, the pump is controlled by Operator selections made from the local OIT or any remote HMI via START-STOP selector switch function HS-01.
a) Pump speed is controlled by PLC flow controller function FIC-01.
(1) When placed in the MANUAL mode at the OIT or HMI, FIC-01 commands the pump to operate at whatever speed is input by the Operator at the OIT/HMI via speed controller faceplate SIC-01.
(2) In AUTO mode, FIC-01 modulates the pump speed to maintain a set flow rate. Flow feedback is provided to FIC-01 by magnetic flowmeter FE/FIT-01.

b. See Control Diagram in Drawings for details of the hardwired interlocks between operation of the pump and the pump discharge control valve. Interlocks are in place regardless of whether the pump is in the LOCAL or REMOTE control mode as selected at the VFD. Interlocks are as follows:
1) Pump is commanded to start against a closed discharge control valve.
2) The pump start command energizes the control valve's solenoid valve and the valve begins to open, gradually increasing line pressure to full pumping head.
3) When the pump is signaled to shut-off, the solenoid valve is de- energized and the valve begins to close slowly, gradually reducing flow while the pump continues to run.
4) When the discharge valve is fully closed as detected by a limit switch assembly, the pump is stopped.
5) The pump will trip via hardwired interlock in the event any of the following conditions occur:
a) Pump motor winding temperature is high-high.
b) Pump discharge pressure rises above a set point for a set period of time.
c) Discharge valve fails to open after a set period of time following pump start.

c. Pump bearing lubrication control:
1) When a pump is requested to start, hardwired relay logic utilizes a time delay to allow water time to lubricate the pump bearings prior to pump start. When the time delay relay actuates it energizes the water solenoid to admit lubricating water to the pump bearings. See Control Diagram for details.

4. Indications at OIT/SCADA HMI:
a. CWP-01 flow rate: FI-01.
b. CWP-01 total flow rate since last reset: FQI-01.
c. Pump pre-lube time: KI-07.
1) Indication provided at OIT/HMI prior to pump start that pump pre-lube is taking place. This indication remains until the pre-lube timer expires. Pre-lube timer is adjustable by the Operator.
d. CWP-01 discharge header pressure high alarm: PAH-01.
e. CWP-01 in REMOTE control mode: ZI-01.
f. CWP-01 fail alarm: XA-01A (pump fails to run within 5 seconds of PLC run command).
g. VFD fault alarm: XA-01B.
h. CWP-01 run status: YI-01.
i. CWP-01 total running time (since last reset): KQI-01.
j. CWP-01 speed: SI-01.
k. Discharge valve closed indication: ZCI-01.
l. CWP-01 motor temperature high-high alarm: TAHH-01.

B. Control Loop 02: Collector Well Pump CWP-02.
1. Description for Control Loop 01 is typical for description for Control Loop 02.

C. Control Loop 03: Collector Well Pump CWP-03.
1. Description for Control Loop 01 is typical for description for Control Loop 02.

D. Control Loop 04: Future Collector Well Pump CWP-04.

E. Control Loop 05: Collector Well Pump Discharge Header Pressure.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Major Field Instruments:
      a. Pump discharge pressure transmitter: PIT-05.
   3. Control Logic:
      a. None; pressure transmitter is utilized for indication only.
   4. Indications at OIT/SCADA HMI:
      a. Collector well pump header pressure indication: PI-05.

F. Control Loop 06: Collector Well Level.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Major Field Instruments:
      a. Collector well level transmitter: LT-06.
   3. Control Logic:
      a. None; level transmitter is utilized for indication and alarm purposes only.
   4. Indications at OIT/SCADA HMI:
      a. Collector well level indication: LI-06.
      b. Collector well high level alarm: LAH-06.

G. Control Loop 07 – PLC Control Panel UPS Alarms.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Control Logic: None.
   3. Indications at OIT/SCADA HMI:
      a. UPS trouble alarm: XA-07A.
      b. UPS on battery power: XA-07B.

H. Control Loop 08 – Switchgear MSB-01 Surge Protection Device Monitoring.
   1. Major Equipment:
      a. Switchgear MSB-01.
      b. PLC and local OIT.
      c. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Control Logic:
      a. SCADA System provides monitoring capabilities only for the switchgear.
   3. Indications at OIT/SCADA HMI:
      a. Switchgear MSB-01 surge protection device trouble alarm: XA-08.

I. Control Loop 09 – Collector Well Smoke Detection Alarm Monitoring.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Major Field Instrumentation:
      a. Collector Well Smoke detector.
   3. Control Logic:
      a. SCADA System provides monitoring capabilities only for the smoke detector.
   4. Indications at OIT/SCADA HMI:
      a. Collector Well smoke detected alarm: XA-09.

J. Control Loop 10 - Generator Monitoring.
   1. Major Equipment:
      a. Vendor-furnished Generator Control Panel.
      b. PLC, Remote I/O Panel and local OIT.
      c. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Control Logic:
      a. All generator control logic resides in control panel(s) furnished by the Generator supplier. SCADA System provides monitoring capabilities only for the generator.
   3. Indications at OIT/SCADA HMI:
      a. Generator run status: YI-10.
      b. Generator trouble alarm: XA-10A.
      c. Generator fail alarm: XA-10B.
      d. Generator fuel low level: LAL-10.
      e. Generator not in AUTO control mode: ZA-10.

K. Control Loop 11 – Switchgear PDP01 Monitoring.
   1. Major Equipment:
      a. Switchgear PDP01.
      b. PLC, Remote I/O Panel and local OIT.
      c. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Control Logic:
      a. SCADA System provides monitoring capabilities only for the switchgear.
   3. Indications at OIT/SCADA HMI:
      a. Switchgear PDP01 surge protection device alarm: XA-11.
      b. Collector Well on Utility Power (Main Utility Breaker closed): ZI-11A.
      c. Collector Well on Generator Power (Generator Breaker closed): ZI-11B.

L. Control Loop 12 – Remote I/O Panel UPS Alarms.
   1. Major Equipment:
      a. PLC, Remote I/O Panel and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Control Logic: None.
   3. Indications at OIT/SCADA HMI:
      a. UPS trouble alarm: XA-12A.
      b. UPS on battery power: XA-12B.

M. Control Loops 50 - 53 – Intrusion Alarms.
   1. Major Equipment:
      a. PLC and local OIT.
      b. SCADA HMIs (PC based HMIs in existing Water Treatment Plant No. 1 and Plant No. 2).
   2. Major Field Instruments:
      a. Door intrusion switch: ZS-50.
      b. North roof hatch intrusion switch: ZS-51.
      c. South roof hatch intrusion switch: ZS-52.
      d. Valve level hatch intrusion switch: ZS-53.
   3. Control Logic:
      a. An alarm is generated at the OIT and the SCADA HMIs immediately whenever any of the following hatches are open:
         1) North roof hatch.
         2) South roof hatch.
         3) Valve level hatch.

b. ACTIVE – BYPASS selector switch HS-50 with key lock is utilized to bypass the door intrusion alarm. An intrusion alarm is generated at the OIT/HMIs after a time delay (adjustable from 0 to 60 seconds) following the opening of the door. No intrusion alarm is generated when HS-50 is in the BYPASS position. Control logic associated with the BYPASS mode and the time delay associated with the ACTIVE mode resides within the PLC.

4. Indications at OIT/SCADA HMI:
   a. Door intrusion alarm: ZA-50.
   b. North hatch intrusion alarm: ZA-51.
   c. South hatch intrusion alarm: ZA-52.
   d. Valve level hatch intrusion alarm: ZA-53.

END OF SECTION

2014/08/28

SECTION 13442
PRIMARY METERS AND TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flow components.
   2. Pressure components.
   3. Level components.
   4. Door and hatch intrusion switches.
   5. Pipe, tubing and fittings.
   6. Instrument valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 13440 - Instrumentation for Process Control: Basic Requirements.
   4. Section 13441 - Control Loop Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
      b. B31.1, Power Piping.
      c. Section II, Part A SA-182, Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      d. Section II, Part A SA-479, Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   2. ASTM International (ASTM):
      a. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      b. A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      d. A276, Standard Specification for Stainless Steel Bars and Shapes.
      e. A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

1.3 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 13441.
   1. These instruments are integrated with other control system components specified under Specification Section 13440 series to produce the functional control defined in the Contract Documents.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 FLOW COMPONENTS

A. Magnetic Flow Meters:
   1. Acceptable manufacturers:
      a. ABB.
      b. Johnson Yokogawa.
      c. Rosemount.
      d. Krohne.
      e. Endress + Hauser.
      f. Seimens.
   2. Design and fabrication:
      a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
      b. High input impedance pre-amplifiers.
         1) Minimum impedance: 10^{10} ohms.
      c. Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions.
      d. Grounding requirements:
         1) Nonmetallic or lined pipe:
            a) Inlet and outlet grounding rings of same material as electrode.
         2) Conductive piping:
            a) Conductive path between the meter and the piping flanges.
      e. Provide cable between magnetic flow meter and transmitter.
      f. Pulsed DC magnetic field excitation.
      g. Automatic zero.
      h. Adjustable low flow cutoff.
      i. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
      j. Inaccuracy:
         1) Above 10 percent of range: +/-1.0 percent of rate.
         2) Below 10 percent of range: +/-0.1 percent of range setting.
         3) Add +0.1 percent of range to above inaccuracies for analog outputs.
      k. 4-20 mA DC isolated output into maximum 800 ohms.
      l. Power supply: 117 V +/-10 percent, 60 Hz.
      m. Indication of flow rate and totalized flow at transmitter.
      n. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.

o. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.

3. Schedule:

TAG NUMBER	SERVICE	FLOW RANGE (GPM)	METER SIZE (IN)
FE/FIT-01	CWP-01 discharge	0-5,000	16
FE/FIT-02	CWP-02 discharge	0-5,000	16
FE/FIT-03	CWP-03 discharge	0-5,000	16

TAG NUMBER	LINER MATERIAL	ELECTRODE MATERIAL	INTEGRAL, FIELD OR PANEL-MOUNTED TRANSMITTER
FE/FIT-01	Rubber	316 SS	Integral
FE/FIT-02	Rubber	316 SS	Integral
FE/FIT-03	Rubber	316 SS	Integral

2.3 PRESSURE COMPONENTS

A. Pressure Transmitters:
1. Acceptable manufacturers:
a. Rosemount, Model 2051.
b. Foxboro, I/A series.
c. Honeywell SmartLine ST 700 series.
2. Materials:
a. Isolating diaphragm: 316 stainless steel.
b. Process flanges and adapters: 316 stainless steel.
c. Housing: Aluminum.
d. Vent/drain valve: 316 stainless steel.
e. Fill fluid:
1) Utilize manufacturer's standard fill for other applications.
a) Ensure fill is suitable for application temperatures.
3. Design and fabrication:
a. Smart transmitters utilizing microprocessor based electronics.
b. Output: 4-20 mA DC proportional to pressure.
c. Nonvolatile EEPROM memory.
d. Power supply: 24 Vdc.
e. Adjustable zero and span.
f. Temperature limits: -20 to 180 DegF.
1) -4 to 175 DegF for LCD indicators.
g. Overpressure limits: Withstand 150 percent of stated maximum service pressure without damage.
h. Humidity limits: 0 to 100 percent relative humidity.
i. Damping: Adjustable between 0 and 32 seconds.
j. Inaccuracy (includes effects of linearity, repeatability and hysteresis): +/-0.10 percent of calibrated span for 15:1 rangeability.
k. Stability: +/-0.2 percent of upper range limit for 12 months.
l. Temperature effect:
1) Total effect including span and zero errors: +/-0.2 percent of upper range limit per 100 DegF for minimum 15:1 rangeability.
m. Minimum 1/2 IN pressure connection.
n. Equip with test jacks or accessible terminals for testing output.
o. Equip with isolation valve and test connections with isolation valves and/or plugs.

4. Schedule:

TAG NUMBER	SERVICE	SPAN
PIT-05	Collector Well pump discharge	0-100 PSI

B. Pressure Switches:
1. Acceptable manufacturers:
   a. Mercoid.
   b. Automatic Switch Company.
   c. United Electric.
2. Materials:
   a. Wetted switch elements: 316 stainless steel.
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
4. Design and fabrication:
   a. Utilize hermetically sealed contact switches.
   b. SPDT contacts rated:
      1) 1 amp inductive at 125 Vdc.
      2) 5 amp inductive at 120 Vac.
   c. Switch set points:
      1) Set points between 30 and 70 percent of switch rated working range.
      2) Operating pressure not to exceed 75 percent of switch rated working range.
   d. Accuracy: Better than 1 percent of full scale.
   e. Process connection: Minimum of 1/4 IN.
5. Schedule:

TAG NUMBER	SERVICE	HIGH SETTING
PSH-01	CWP-01 discharge	TBD
PSH-02	CWP-02 discharge	TBD
PSH-03	CWP-03 discharge	TBD

C. Pressure Gage:
1. Acceptable manufacturers:
   a. Ashcroft.
   b. Ametek.
2. Materials:
   a. Bourdon tube, socket, connecting tube: 316 stainless steel.
   b. Case: Phenolic.
3. Accessories:
   a. Provide valve at point of connection to equipment and at panel if panel mounted.
4. Design and fabrication:
   a. Provide viewer protection from element rupture.
   b. Calibrate gages at jobsite for pressure and temperature in accordance with manufacturer's instructions.
   c. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with dial diameter as follows:

PIPE SIZE	DIAL SIZE	GAGE CONNECTION
1-1/2 IN or less	2-1/2 IN	1/4 IN
Larger than 1-1/2 IN	4-1/2 IN	1/2 IN

   d. Equip with white faces, black numerals and black pointers.

e. Gage tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
   1) Gage to be readable from an accessible standing position.
f. Gage accuracy: 1 percent of full range.
g. Select gage range so that:
   1) The normal operating value is in the middle third of the dial.
   2) Maximum operating pressure does not exceed 75 percent of the full scale range.

D. Schedule:

TAG NUMBER	APPLICATION	PRESSURE RANGE (PSI)	DIAL SIZE (IN)	LIQUID FILLED
PI-01	CWP-01	0-160	4 1/2	Yes
PI-02	CWP-02	0-160	4 1/2	Yes
PI-03	CWP-03	0-160	4 1/2	Yes
PI-05	Collector Well Pump Discharge	0-160	4 1/2	No

2.4 LEVEL ELEMENTS

A. Submersible Type Level Transmitters:
   1. Acceptable Manufacturers:
      a. Siemens SITRANS P, MPS series.
      b. Endress + Hauser Waterpilot FMX 21.
   2. Materials:
      a. Sensor wetted materials: 316 stainless steel, Viton, Teflon, or equivalent.
      b. Cable insulation/jacket: Polyethylene, polyurethane, or equivalent.
      c. Terminal box: As required to meet area classifications shown on drawings.
      d. Cable/sensor installation devices: Polyethylene, Teflon, 316 stainless steel.
   3. Design and fabrication:
      a. Two-wire, 24 Vdc loop-powered.
      b. Supply voltage: 24 Vdc.
      c. Output signal: 4-20 mA.
      d. Barometric pressure tube with Teflon filter or desiccant located in dry junction box or control panel.
      e. Operating temperature: 14 to 158 DegF.
      f. Ambient temperature: -14 to 158 DdegF.
      g. Over range protection: Up to twice specified span.
      h. Strain relief cable clamp for suspending cable.
      i. Maximum measured error: ±0.5 percent of upper range value.
      j. Stability: ±0.25 percent of upper range value per year.
      k. Integral transient overvoltage protection.
   4. Schedule:

TAG NUMBER	SERVICE	SPAN, FT
LT-06	Collector Well	0-TBD

2.5 DOOR AND HATCH INTRUSION SWITCHES

A. Acceptable Manufacturer:
   1. GO SWITCH.

B. Design and Operation:
   1. Hermetically sealed, leverless operation switch.
   2. Side sensitive.
   3. Potted cable connections.

4. Suitable for outdoor use.
5. Door sensors are side sensitive, style 11 looking at a magnetic metal target or range extending magnet assembly attached to the door.
6. Schedule:

TAG NUMBER	SERVICE	CONTACT NO/NC
ZS-50	Door open switch	NO
ZS-51	North hatch open switch	NO
ZS-52	South hatch open switch	NO
ZS-53	Valve Level hatch open switch	NO

2.6 PIPE, TUBING, AND FITTINGS

A. Acceptable Manufacturers:
   1. Tube fittings:
      a. Parker CPI.
      b. Swagelok.

B. Instrument Tubing and Fittings:
   1. Material:
      a. Tubing: ASTM A269, Grade TP 316 stainless steel.
      b. Straight fittings: 316 stainless steel per ASME SA-479 or ASTM A276.
      c. Shaped bodies: ASME SA-182 F316 stainless steel.
   2. Design and fabrication:
      a. Tubing:
         1) Seamless.
         2) Fully annealed.
         3) Maximum hardness: 80 Rb.
         4) Free from surface scratches and imperfections.
         5) Diameter: 1/2 IN OD unless specified otherwise.
         6) Wall thickness:
            a) Meet requirements of ASME B31.1, Paragraph 122.3.
            b) Minimum 0.049 IN for 1/2 IN OD tubing.
      b. Fittings:
         1) Flareless.
         2) Compression type.

C. Instrument Piping:
   1. For applications where the instrument is supported solely by the sensing line, (e.g., pressure gauge directly mounted to process line), utilize piping as specified below.
      a. Diameter: 1/2 IN unless specified otherwise.
      b. Schedule 80.
      c. ASTM A106 Grade B carbon steel with steel fittings per ASTM A234.

2.7 INSTRUMENT VALVES

A. Process instrument multi-valve manifolds, isolation, vent and blow-down valves:
   1. Acceptable manufacturers:
      a. Whitey Co.
      b. Anderson-Greenwood USA, Inc.
   2. Materials:
      a. Packing: Graphite or Teflon.
      b. Body: 316 stainless steel per ASTM A479.
      c. Stem: 316 stainless steel per ASTM A276.
      d. Ball: 316 stainless steel per ASTM A276.
      e. Support rings: 316 stainless steel per ASTM A276.

f. Seats:
1) Metal:
a) 316 stainless steel per ASTM A276.
2) Soft:
a) Teflon, Delrin.
b) Only utilized on applications where manufacturer's temperature and pressure ratings exceed process design conditions.

3. Design and fabrication:
a. Either of the following:
1) Ball valve with 1/4 turn activation.
2) Free-swiveling ball stem.
b. Provide body wall thickness sufficient for process design conditions per ASME B31.1.
c. Temperature: Manufacturer's temperature rating for all components shall exceed process design conditions.

2.8 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets, plates, angles: 316 stainless steel.
c. Instrument pipe stands:
1) Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.

B. Tubing Support Angles and Brackets:
1. Any of the following materials are acceptable:
a. Aluminum support with dielectric material between support and tubing.
b. Type 316 stainless steel.
c. Fiberglass.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:
1. Orient stems for proper operation.
2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
a. When cool, reassemble the valves.
5. Support each valve individually.
a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Tubing Installation:
   1. General:
      a. Install such that tube shows no sign of crumpling, bends of too short a radius, or flattening, etc.
      b. Make tube runs straight and parallel or perpendicular to the floor, equipment and piping runs.
      c. For liquid and steam applications, slope continuously from the process to the instrument with a minimum slope of 0.50 IN per foot.
      d. For gas and air applications, slope continuously from the instrument to the process with a minimum slope of 0.50 IN per foot.
      e. If the sensing line cannot be continuously sloped, install high point vents and low point drains.
      f. Keep instrument tubing clean during all phases of work.
      g. Blow out with clean, dry, oil-free air immediately before final assembly.
      h. Cut by sawing only and debur.
   2. Bending:
      a. Make each bend with tube bender of the correct size for the tube.
      b. Make all bends smooth and continuous.
      c. Rebending is not permitted.
      d. Make bends true to angle and radius.
      e. Maintain a true circular cross section of tubing without buckling or undue stretch of tube wall.
      f. Allowable tolerance for flattening out of tubing bends: Maximum of 8 percent of the OD for stainless steel tubing.
      g. Minimum bending radius for stainless steel tubing:

TUBE OD, INCHES	MINIMUM BENDING RADIUS, INCHES
1/4	9/16
3/8	15/16
1/2	1-1/2

   3. Tubing support:
      a. Intermittently support by clamping to support angle.
      b. Install supports to be self-draining, supported by hangers, or cantilevered from walls or structural beams.
      c. Support at 5 FT-0 IN maximum spans for horizontal or vertical runs.
      d. Align tubing in orderly rows and retain in the tray by bolted clips.
         1) The use of spring or speed clips is not acceptable.
      e. Maintain order of the tubing throughout the length of the tray.
      f. Locate angle, channel and tray installation to protect tubing from spills and mechanical damage.
      g. Locate support members to clear all piping, conduit, equipment, hatchways, monorails, and personnel access ways and allow access for equipment operation and maintenance.
      h. Permanently attach supports to building steel or other permanent structural members.
      i. Arrange supports and trays so that they do not become a trough or trap.
   4. Routing and orientation:
      a. Route to maintain a minimum headroom clearance of 8 FT.
      b. Locate and orient valves and specialties so that they are accessible for operation and maintenance from the operating floor.
         1) Do not route through or over equipment removal areas, below monorails or cranes nor above or below hatches.

I. Threaded Connection Seals:
   1. Use Tite-Seal or acceptable alternate.
   2. Use of lead base pipe dope or Teflon tape is not acceptable.
   3. Do not apply Tite-Seal to tubing threads of compression fittings.

J. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protection from heat, shock, and vibrations.
      b. Accessibility for maintenance.
      c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01650.

END OF SECTION

1

2014/08/14

SECTION 13446
CONTROL AUXILIARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Relays/timers:
      a. Control relay.
      b. Time delay relays.
   2. Termination equipment:
      a. Terminal blocks.
      b. Fuse holders.
   3. Power supplies:
      a. DC power supplies.
      b. Isolation transformers.
      c. Uninterruptible power supplies.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL).

B. Miscellaneous:
   1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

C. Submit request for substitution in accordance with Specification Section 01640.

2.2 RELAYS/TIMERS

A. Control Relays:
   1. Acceptable manufacturers:
      a. Idec.
      b. Potter & Brumsfield.
      c. Allen-Bradley.
   2. Design and fabrication:
      a. Plug-in general purpose relay.
      b. Blade connector type.
      c. Switching capacity: 10 A.
      d. Contact material: Silver cadmium oxide.
      e. Provide relays with a minimum of 3 SPDT contacts.
      f. Coil voltage: 120 Vac or 24 Vdc.
      g. Relay sockets are DIN rail mounted.
      h. Internal neon or LED indicator is lit when coil is energized.
      i. Clear polycarbonate dust cover with clip fastener.
      j. Check button.
      k. Temperature rise:
         1) Coil: 85 DegF maximum.
         2) Contact: 65 DegF maximum.
      l. Insulation resistance: 100 Meg minimum.
      m. Frequency response: 1800 operations/hour.
      n. Operating temperature: -20 to +150 DegF.
      o. Life expectancy:
         1) Electrical: 250,000 operations or more.
         2) Mechanical: 10,000,000 operations or more.
      p. UL listed or recognized.

B. Signal-Level Switching Relays:
   1. Acceptable manufacturers:
      a. Idec.
      b. Potter & Brumsfield.
   2. Design fabrication:
      a. Minimum of 2 SPDT gold-flashed, bifurcated contacts.
      b. Hermetically sealed.
      c. Rated at 3 A resistive at 120 Vac or 24 Vdc.

C. Time Delay Relays:
   1. Acceptable manufacturers:
      a. Eagle Signal Controls.
      b. Idec.
   2. Design and fabrication:
      a. Melt design test and performance requirements of NEMA ICS 2-218.
      b. Heavy-duty.
      c. Solid-state construction.
      d. External adjusting dial.
      e. Auxiliary relays as required to perform functions specified or shown on Drawings.
      f. Operates on 117 Vac (±10 percent) power source.
      g. Contact rating: A150 per NEMA ICS 2-125.
      h. Furnish with "on" and "timing out" indicators.

2.3 TERMINATION EQUIPMENT

A. Terminal Blocks:
   1. Acceptable manufacturers:
      a. Phoenix Contact.
      b. Allen-Bradley.
   2. Design and fabrication:
      a. Modular type with screw compression clamp.
      b. Screws: Stainless steel.
      c. Current bar: Nickel-plated copper allow.
      d. Thermoplastic insulation rated for -40 to +90 DegC.
      e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
      f. Install end sections and end stops at each end of terminal strip.
      g. Install machine-printed terminal markers on both sides of block.
      h. Spacing: 6 mm.
      i. Wire size: 22-12 AWG.
      j. Rated voltage: 600 V.
      k. Din rail mounting.
      l. UL listed.
   3. Standard-type block:
      a. Rated current: 30 A.
      b. Color: Gray body.
   4. Bladed-type block:
      a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
      b. Rated current: 10 A.
      c. Color:
         1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
         2) Foreign voltage entering enclosure: Orange body, orange switch.
   5. Grounded-type block:
      a. Electrically grounded to mounting rail.
      b. Use to terminal ground wires and analog cable shields.
      c. Color: Green and yellow body.

B. Fuse Holders:
   1. Acceptable manufacturers:
      a. Phoenix Contact.
      b. Allen-Bradley.
   2. Design and fabrication:
      a. Modular-type with screw compression clamp.
      b. Screws: Stainless steel.
      c. Current bar: Nickel-plated copper alloy.
      d. Thermoplastic insulation rated for -40 to +105 DegC.
      e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
      f. Blocks can be ganged for multi-pole operation.
      g. Install end sections and end stops at each end of terminal strip.
      h. Install machine-printed terminal markers on both sides of block.
      i. Spacing: 9.1 mm.
      j. Wire size: 30-12 AWG.
      k. Rated voltage: 300 V.
      l. Rated current: 12 A.
      m. Fuse size: 1/4 x 1-1/4.
      n. Blown fuse indication.
      o. DIN rail mounting.
      p. UL listed.

2.4 POWER SUPPLIES

A. DC Power Supplies:
   1. Acceptable manufacturers:
      a. Sola Hevi-Duty.
      b. Phoenix Contact.
      c. Rockwell Automation.
   2. Design and fabrication:
      a. Converts 120 Vac input to DC power at required voltage.
      b. DIN rail mount with enclosure (i.e., not open frame).
      c. Switching type.
      d. AC input: 120 Vac +/-15 percent, nominal 60 Hz.
      e. Efficiency: Minimum 86 percent.
      f. Rated mean time between failure (MTBF): 500,000 HRS.
      g. Voltage regulation:
         1) Static: Less than 1.0 percent V_{out}.
         2) Dynamic: +/-2 percent V_{out} overall.
      h. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
      i. Overload, short circuit and open circuit protection.
      j. Temperature rating: 0 to 60 DegC full rated, derated linearly to 50 percent at 70 DegC.
      k. Humidity rating: Up to 90 percent, non-condensing.
      l. LED status indication for DC power.

B. Isolation Transformers:
   1. Acceptable manufacturers:
      a. Topaz Noise Suppressor Noise Isolator.
      b. MGE UPS Systems, Topaz T1.
   2. Design and fabrication:
      a. Protects sensitive electronic equipment from electrical noise.
      b. Common-mode noise attenuation: 146 dB at 0.0005 pF coupling capacitance.
      c. Normal-mode attenuation: 60 dB.
      d. Input voltage range: ±10 percent of rated.
      e. Regulation: 3.5 percent or less from full-load to no-load.
      f. Dielectric strength: 2,500 Vac minimum.
      g. Harmonic distortion: 1 percent maximum.
      h. Electromagnetic interference: 0-1 gauss maximum at 18 IN.
      i. UL listed.

C. Uninterruptible Power Supplies (UPS):
   1. Acceptable manufacturers:
      a. Double conversion type to be utilized in conjunction with input isolation transformer:
         1) Powerware 9130 UPS.
      b. UPS with integral isolation transformer:
         1) Best FERRUPS.
         2) Controlled Power Co. LT series.
   2. Design and fabrication:
      a. Minimum 15 minutes power ride through without incoming power.
      b. Frequency range: 45-65 Hz.
      c. Input protection:
         1) Fuse or circuit breaker.
      d. Output voltage regulation:
         1) ±2 percent online.
         2) ±3 percent on battery mode.
      e. Battery: Sealed, lead-acid; maintenance free.
      f. Operating temperature: 32 to 104 DegF.
      g. Relative humidity: 0-95 percent non-condensing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

END OF SECTION

1

2014/08/14

SECTION 13447
TELEMETRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Items required include but are not necessarily limited to the following:
      a. Radios.
      b. Antennas, masts, and associated appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 13440 - Instrumentation for Process Control: Basic Requirements.
   5. Section 13441 - Control Loop Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Federal Communications Commission (FCC):
      a. 47 CFR 15 - Radio Frequency Devices, Section 15.247 - Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Product technical data:
      a. As required by Specification Section 13440.
      b. Manufacturer's installation instructions.
   4. Submit all catalog cut sheets under Specification Section 13447 submittals.

B. Miscellaneous Submittals: Results of factory testing procedures.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 RADIOS

A. Acceptable Manufacturers:
   1. Microwave Data Systems (MDS) iNET II.
      a. No “or equals” accepted.

B. Design and Fabrication:
   1. Communication:
      a. Type:
         1) Ethernet communication in accordance with IEEE 802.3.
   2. Security: 128-bit data encryption.
   3. License free.
   4. Frequency hopping spread spectrum.
   5. Frequency band: 902-928 MHz.
   6. Configuration:
      a. Provide remote configuration capability.
         1) Provide licensed copies to the Owner of any software required for remote configuration.
   7. Error detection/correction: 16 bit CRC with ARQ (Automatic Re-send Query).
   8. Input power: 10.5-24 Vdc.
   9. Case: Aluminum.
   10. Agency approvals: FCC 47 CFR 15.247.

C. Schedule: See schedule below for both radio and antenna.

2.3 ANTENNAS, TOWERS AND MASTS

A. Antenna:
   1. Acceptable Manufacturer:
      a. Sinclair SP-440.
   2. Design and Fabrication:
      a. ABS radome-enclosed log-periodic antenna.
      b. 200 MHz bandwidth.
      c. Hardware and fastenings: stainless steel.

B. Antenna Mounting:
   1. Provide all masts, supports, lightning suppressors, and other apparatus required to make a complete and operable radio telemetry system.
   2. Lightning protected: Mast or tower direct connected to ground.
   3. Mast materials:
      a. Antenna Mounting Hardware:
         1) 316 stainless steel or aluminum.
   4. Schedule:

APPLICATION	RADIO	ANTENNA HEIGHT (FT ABOVE GRADE)	TOWER/MAST TYPE
Collector Well	Remote Slave Radio	15	2-IN Pipe Attached to Building (See Installation Detail)

2.4 TRANSMISSION CABLE AND MISCELLANEOUS

A. Acceptable Cable Manufacturers:
   1. Andrew Corp. LDF Series.
   2. Times Microwave Systems LMR Series.

B. Provide low-loss foam-dielectric type cable connecting radio antenna port(s) with the antenna.
   1. Cable: 1/2 IN or larger diameter as required to prevent signal losses in cable from degrading performance.
   2. Weatherproof, suitable for direct environmental exposure.
      a. Use "O" ring seals on connections.

C. Provide "superflexible" transmission cable (length as required) at the radio antenna port.
   1. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

D. Provide antenna surge suppressor and connect to coaxial cable in cabinet housing radio.
   1. Acceptable manufacturer:
      a. Polyphaser.

E. Provide grounding connections to the antenna mast and cable in accordance with manufacturer's recommendations.

2.5 ACCESSORIES

A. Provide all accessories required to furnish a complete telemetry system to accomplish the requirements of the Drawings and Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install radio telemetry system as shown on Drawings in accordance with manufacturer's written instruction.

B. Provide documentation verifying the data communication rate (actual throughput), signal strength and signal quality for the Collector Well radio.

3.2 FIELD QUALITY CONTROL

A. Conduct startup of equipment and perform operational checks.

B. Maintain and submit an accurate daily or weekly log of all commissioning and startup functions.
   1. All commissioning/startup functions may be witnessed by the Engineer.
   2. All reports shall be signed and dated by the Contractor.

C. Provide Owner with a written statement that equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.3 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01650.

END OF SECTION

1

2014/08/28

SECTION 13448
CONTROL PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for control panels and enclosures utilized as follows:
      a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Specification Section 13442, Specification Section 13446, Specification Section 13447, Specification Section 13449 or Specification Section 13500.

B. This Specification Section is only applicable to panels furnished with Division 11 equipment packages when so stated in the applicable Division 11 Specification Section.

C. This Section is only applicable to panels housing Division 16 specified equipment (e.g., motor starters, lighting controls, etc.) when so stated in the applicable Division 16 Specification Section.

D. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Division 11 - Equipment.
   5. Section 13440 - Instrumentation for Process Control: Basic Requirements.
   6. Section 13442 - Primary Elements and Transmitters.
   7. Section 13446 - Control Auxiliaries.
   8. Section 13449 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
   9. Section 13500 - Programmable Logic Controller (PLC) Control System.
   10. Division 16 - Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. B75, Standard Specification for Seamless Copper Tube.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 409, Industrial Control Panels.
   5. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Safety Industrial Control Panels.

B. Miscellaneous:
   1. Approved supplier of Industrial Control Panels under provisions of UL 508A.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
      b. Control panel(s) without an affixed UL 508A label shall be rejected and sent back to the Contractor’s factory.

1.3 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:
   1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
   2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

E. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

F. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

G. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

H. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

I. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

K. Highway Addressable Remote Transducer (HART): An open, master-slave protocol for bus addressable field instruments.

L. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

M. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

N. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Prepared with computer aided design (CAD) software.
   4. Printed on 11 by 17 IN sheets.
   5. Drawings shall include a title block containing the following:
      a. Plant or facility name where panel(s) are to be installed.

b. Drawing title.
c. Drawing number.
d. Revision list with revision number and date.
e. Drawing date.
f. Drawing scale.
g. Manufacturer name, address, and telephone number.

6. Cover sheet for each drawing set shall indicate the following:
   a. Plant or facility name.
   b. Project name.
   c. Submittal description.
   d. Revision number.
   e. Issue date.
7. Table of contents sheet(s) shall indicate the following for each drawing in the set:
   a. Drawing number.
   b. Drawing title.
   c. Sheet number.
8. Legend and abbreviation sheet shall indicate the following:
   a. Description of symbols and abbreviations used.
   b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
   c. Confirmation that the panel(s) are to be affixed with a UL 508A label prior to shipment from the factory.
9. Bill of Material for each panel shall include the following component information:
   a. Instrument tag number.
   b. Quantity.
   c. Functional name or description.
   d. Manufacturer.
   e. Complete model number.
   f. Size or rating.
10. Panel exterior layout Drawings to scale and shall indicate the following:
   a. Panel materials of construction, dimensions, and total assembled weight.
   b. Panel access openings.
   c. Conduit access locations.
   d. Front panel device layout.
   e. Nameplate schedule:
      1) Nameplate location.
      2) Legend which indicates text, letter height and color, and background color.
   f. Alarm annunciator window engraving schedule.
   g. Layouts of graphic panels or mosaic displays.
11. Panel interior layout Drawings shall be drawn to scale and shall indicate the following:
   a. Sub-panel or mounting pan dimensions.
   b. Interior device layouts.
   c. PLC/Remote I/O rack general arrangement layouts.
   d. Wire-way locations, purpose, and dimensions.
   e. Terminal strip designations.
   f. Location of external wiring and/or piping connections.
   g. Location of lighting fixtures, switches and receptacles.
12. Wiring diagrams shall consist of the following:
   a. Panel power distribution diagrams.
   b. Control and instrumentation wiring diagrams.
   c. PLC/Remote I/O information:
      1) Model number of I/O module.
      2) Description of I/O module type and function.
      3) Rack and slot number.
      4) Terminal number on module.
      5) Point or channel number.

6) Programmed point addresses.
7) Signal function and type.

d. Wiring diagrams shall identify each wire as it is to be labeled.

B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

C. Electrical load calculations for each panel:
1. Total connected load.
2. Peak electrical demand for each panel.

D. Climate control calculations for each panel.
1. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

E. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.
2. See Specification Section 13440.

F. Informational Submittals:
1. Record Drawings:
   a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
   b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Enclosures:
   a. Hoffman Engineering Co.
   b. Rittal.
   c. Hammond Manufacturing.
   d. Millbank Mfg. Co.
2. Panel heaters:
   a. Hoffman Enclosures, Inc.
   b. Rittal.
   c. Hammond Manufacturing.
3. Cooling fans and exhaust packages:
   a. Hoffman Enclosures, Inc.
   b. Rittal.
4. Internal corrosion inhibitors:
   a. Hoffman Enclosures, Inc.; Model A-HCI.
   b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
   c. Cortec Corporation; Model VpCl Emitting Systems.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 ACCESSORIES

A. Panel Nameplates and Identification: See Section 10400.

2.3 FABRICATION

A. General:
   1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
   2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
   3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
      a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
      b. The window shall maintain the required NEMA rating of the enclosure.
   4. Panel(s) shall be completely assembled at the Contractor's factory.
      a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
   5. Painting:
      a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
         1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
         2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
         3) Utilize solvent or chemical methods to clean panel surfaces.
         4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
         5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
         6) Bake powder coating at high temperatures to bond coating to enclosure surface.
            a) Panel interior shall be white with semi-gloss finish.
            b) Panel exterior shall be ANSI #61 gray with flat finish.
         7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
      b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
   6. Finish opening edges of panel cutouts to smooth and true surface conditions.
      a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
   7. Panel shall meet all requirements of UL 508A.
      a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."
   8. Provide control panel in accordance with NFPA 70, Article 409.
      a. In the event of any conflict between NFPA 70, Article 409 and UL 508A, the more stringent requirement shall apply.

B. Free-Standing Panels:
   1. Welded construction.
   2. Completely enclosed, self-supporting, and gasketed dusttight.
   3. Rolled lip around all sides of enclosure door opening.
   4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
   5. Full height, fully gasketed flush pan doors.
   6. Full length piano hinges rated for 1.5 times door plus instrument weight.
   7. Doors with keyed alike locking handles and three-point catch.
   8. Appropriate conduit, wiring, and instrument openings shall be provided.
   9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:
   1. Seams continuously welded and ground smooth.

2. Rolled lip around all sides of enclosure door opening.
3. Gasketed dust tight.
4. Three-point latching mechanism operated by oil tight key-locking handle.
5. Key doors alike.
6. Continuous heavy GA hinge pin on doors.
    a. Hinges rated for 1.5 times door plus instrument weight.
7. Front full opening door.
8. Brackets for wall mounting.

D. Internal Panel Wiring:
1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
    a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
    b. Follow wire-duct manufacturer's recommended fill limits.
    c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
    d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Wiring shall be installed such that if wires are removed from one (1) device, source of power will not be disrupted to other devices.
3. Splicing and tapping of wires permitted only at terminal blocks.
4. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
    a. Protect bend area with sleeve.
5. Arrange wiring neatly, cut to proper length, with surplus wire removed.
    a. Arrange wiring with sufficient clearance.
    b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
6. AC circuits shall be routed separate from analog signal cables and digital signal cables.
    a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.
7. Provide at least 6 IN of separation between intrinsically safe devices and circuits and non-intrinsically safe devices and circuits.
8. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
9. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DegC.
    a. Conductor size shall be as required for load and 16 AWG minimum.
    b. Internal panel wiring color code:
        1) AC circuits:
            a) Power wiring: Black.
            b) Control interconnections: Yellow.
            c) Neutral: White.
            d) Ground: Green.
        2) Low voltage DC circuits:
            a) Power wiring: Blue.
            b) Control interconnections: Violet.
        3) Foreign voltage circuits: Pink.
        4) Annunciator circuits: Red.
        5) Intrinsically safe circuits: Orange.
10. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
    a. Conductor size: 18 AWG minimum.
    b. Terminate shield drain conductors to ground only at one (1) end of the cable.

11. High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4-20 mA DC analog signals are converted to 1-5 Vdc signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
12. Analog signals for devices in separate enclosures shall not be wired in series.
    a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
13. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.
    b. Wire tags:
        1) Slip-on, PVC wire sleeves with legible, machine-printed markings.
        2) Adhesive, snap-on, or adhesive type labels are not acceptable.
    c. Markings as identified in the Shop Drawings.

E. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
    a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus.
    a. It is imperative that good electrical connections are made at the point of contact between the ground bus and enclosure.
5. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
6. Sub-panels and doors shall be bonded to ground.

F. Termination Requirements:
1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
4. One (1) side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
5. Terminal block markings:
    a. Marking shall be the same as associated wire marking.
    b. Legible, machine-printed markings.
    c. Markings as identified in the shop drawings.
6. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
7. Terminal blocks with continuous marking strips.
    a. Each terminal block shall be identified with machine printed labels.
8. Terminals shall facilitate wire sizes as follows:
    a. 120 Vac applications: Conductor size 12 AWG minimum.
    b. Other: Conductor size 14 AWG minimum..
9. Analog signal cable shield drain conductors shall be individually terminated.
10. Install minimum of 20 percent spare terminals.
11. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.
12. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.

13. Fused terminal blocks shall be provided with blown fuse indicators.
14. When control circuits require more than one (1) field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one (1) field conductor per terminal block.
15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.

G. Component Mounting and Placement:
1. Components shall be installed per manufacturer instructions.
2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
3. Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor, unless otherwise shown in the Contract Documents.
4. PLC and I/O rack installation:
   a. Located such that the LED indicators and switches are readily visible with the panel door open.
   b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
5. Locate power supplies with sufficient spacing for circulation of air.
6. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC/RTU system components, provide a barrier of at least 6 IN of separation between the “power area containing the electromagnetic devices” and the “control area”.
7. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
   a. Fastening devices shall not project through the outer surface of the panel enclosure.
8. Excess mounting space of at least 20 percent for component types listed below to facilitate future expansion:
   a. Fuse holders.
   b. Circuit breakers.
   c. Control relays.
   d. Time delay relays.
   e. Intrinsically safe barriers and relays.
9. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.
   a. Minimum of 2 IN separation between terminal strips and wire ducts.

H. Power Distribution:
1. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
   a. Limit load to maximum of 80 percent of circuit breaker rating.
2. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
   a. PLC power supply modules.
   b. As required.
3. Each control panel with PLC components shall be furnished with power protection in the form of a double conversion UPS.
4. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.
5. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.

I. Internal Panel Lighting and Service Receptacles:
1. Panels less than or equal to 4 FT wide:
   a. One (1) electrical GFCI duplex receptacle.
   b. One (1) compact fluorescent light fixture with manual switch(es).

2. Panels or panel faces greater than 4 FT wide:
    a. One (1) duplex electrical GFCI receptacle per 6 FT of length.
    b. Continuous fluorescent lighting strip with manual switches.

J. Environmental Controls:
1. Indoor panels located in a designated electrical room or control room:
    a. Thermostat controlled cooling fans if required to preclude hot spots from exceeding allowable temperature inside panel(s).
    b. Internal corrosion inhibitors.
2. Indoor panels not located within a designated electrical room or control room:
    a. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels.
    b. Thermostat controlled cooling fans if required to preclude hot spots from exceeding allowable temperature inside panel(s).
    c. Internal corrosion inhibitors.
3. Environmental control components:
    a. Panel heaters:
        1) Thermostat controlled.
        2) Components mounted in an anodized aluminum housing.
        3) Designed for sub-panel mounting.
        4) Powered from 120 Vac and protected with a dedicated circuit breaker.
    b. Cooling fans:
        1) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
        2) Powered from 120 Vac and protected with a dedicated circuit breaker.
    c. Internal corrosion inhibitors:
        1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
        2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
        3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

2.4 MAINTENANCE MATERIALS

A. Extra Materials:
1. One (1) quart of exterior finish touch-up paint.
2. One (1) complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Scope: Inspect and test entire panel assembly to verify readiness for shipment.

B. Location: Contractor's factory.

C. Factory Tests:
1. Tests shall be fully documented and signed by the Contractor's factory supervisor.
2. The panel shop shall fully test the control panel for correct wiring.
    a. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.
3. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.
4. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.
5. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.

6. The following functions shall be tested as a minimum:
    a. Demonstrate functions of the panel(s) required by the Contract Documents.
    b. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
    c. Simulate and test each discrete signal at the field terminal strips.
    d. Simulate and test each analog signal using loop calibrators.
    e. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases or radio.
    f. Correct operation of all digital communication devices.
    g. Demonstrate online and offline diagnostic tests and procedures.
    h. The Contractor shall notify the Engineer in writing a minimum of 15 calendar days prior to the Factory Tests.
        1) Engineer has the option to witness all required tests.
7. Make following documentation available to the Engineer at test site during the tests:
    a. Contract Documents.
    b. Factory Demonstration Testing procedures.
    c. List of equipment to be testing including make, model, and serial number.
    d. Shop Drawing submittal data for equipment being tested.
8. Deficiencies shall be corrected prior to shipment from the Contractor's factory.

3.2 INSTALLATION

A. Install free-standing panels on 4 IN high concrete housekeeping pads.

B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

3.3 SCHEDULE

A. Schedule:

LOCATION/SERVICE	TYPE	MATERIAL	NEMA RATING
Collector Well PLC Panel	Wall Mount	Steel	NEMA 12
Remote I/O Panel	Rack Mount	Steel	NEMA 4

END OF SECTION

2014/08/14

SECTION 13449

SURGE PROTECTION DEVICES (SPD) FOR INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Type IC1 SPD - Dedicated 120 Vac circuit, series connection, control panel mounted.
2. Type IC2 SPD – not used.
3. Type IC3 SPD - Discrete 120 Vac control signal, control panel mounted.
4. Type IC4 SPD - not used.
5. Type IC5 SPD - not used.
6. Type IC6 SPD - not used.
7. Type IC7 SPD - Discrete low voltage control signal, control panel mounted.
8. Type IC8 SPD - not used.

B. Related Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. LS 1, Low Voltage Surge Protection Devices.
3. Underwriters Laboratories, Inc. (UL):
   a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
   b. 1283, Standard for Safety Electromagnetic Interference Filters.
   c. 1363, Standard for Safety Relocatable Power Taps.
   d. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:
1. Provide devices for a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
2. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

B. Let-Through Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet it specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may vary by mode.

E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

F. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
   2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      a. The N-G mode is not included in the per phase calculation.

G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. For named products, submit only a catalog cut sheet.
      a. For all other products, submit the data required below.
   3. See Specification Section 13440.
   4. Product technical data for non-specified models:
      a. Manufacturer's experience.
      b. Standard catalog cut sheet.
      c. Electrical and Mechanical Drawings showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Create a Product Data Sheet for each different model number of SPD provided.
         1) Data in the Product Data Sheet heading:
            a) SPD Type per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
            c) Date of signature.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.5 WARRANTY

A. The manufacturer shall provide a minimum of a five (5) year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers model numbers listed in the individual product paragraphs below are acceptable.

2.2 TYPE IC1 SPD

A. Approved Products:
   1. Eaton AGSHW CH-120N-15-XS.
   2. EDCO HSP121BT-1RU.
   3. MTL MA15/D/1/SI.
   4. Phoenix Contact SFP 1-20/120AC (2856702).

B. Standards: UL 1449.

C. Design:
   1. General:
      a. Mounted internally to control panels for point-of-use loads.
      b. MOV based or multi-stage hybrid solid state high performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
      f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
   2. Operating voltage: 120 Vac.
   3. Operating current: 15A minimum.
   4. Operating frequency: 45 to 65 Hz.
   5. Modes of protection: All modes, L-N, L-G and N-G.
   6. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
   7. Maximum surge current: 20,000A per phase, 10,000A per mode minimum.
   8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 percent deviation of the clamping voltage.
   9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection.
      a. External protection as recommended by manufacturer.
   10. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 degree phase angle:

		IEEE C62.41		
System Voltage	**Test Mode**	**B Comb. Wave**	**A Ring Wave**	**UL 1449**
L-N = 120 V	L-N	400 V	300 V	330 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	400 V

2.3 TYPE IC3 SPD

A. Approved Products:
   1. EDCO DRS-130RMS.
   2. MTL MA-15/D/1/SI.
   3. MTL SD-150X.
   4. Phoenix Contact PT 2x1VA-120AC-ST (2839185) with PT BE/FM (2839282) base for non-isolated wiring.
   5. Phoenix Contact PT-2 PE/S-120 AC-ST (2839334 with PT-BE/FM (2839282) base for isolated wiring.

B. Standards: UL 497B or UL 1449.

C. Design:
   1. General:
      a. Mounted internally to control panels for point-of-use loads.
      b. Multi-stage hybrid solid state high performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
      f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
   2. Operating voltage: 120 Vac.
   3. Operating current: 3 A minimum.
   4. Operating frequency: 45 to 65 Hz.
   5. Modes of protection: L-N; when ground conductor is present L-G and N-G.
   6. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
   7. Maximum surge current: 6000 A per phase, 3000A per mode minimum.
   8. Minimum repetitive surge current capacity:
      a. The SPD shall meet one (1) of the following:
         1) 1000 occurrences of a 200A, 10x1000 microsecond waveform.
         2) 400 occurrences of a 500A, 10x1000 microsecond waveform.
         3) 100 occurrences of a 400A, 10x700 microsecond waveform.
         4) 100 occurrences of a 2000A, 8x20 microsecond waveform.
   9. Maximum clamping voltages, measured from the zero voltage reference:
      a. The SPD shall meet one (1) of the following:
         1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
         2) IEEE B3 combination wave: 250 percent of system voltage.
         3) IEEE B3 ring wave: 200 percent of system peak voltage.
         4) IEEE A3 ring wave: 200 percent of system peak voltage.
         5) Mode N-G clamping voltage may be 175 percent higher than the L-G levels.

2.4 TYPE IC7 SPD

A. Approved Products:
   1. Eaton DDIN Series.
   2. EDCO DRS Series.
   3. MTL SD Series.
   4. Phoenix Contact: PT Series.

B. Standards: UL 497B.

C. Design:
   1. General:
      a. Mounted internally to control panels for protection of equipment connected to a discrete signal.
      b. Multi-stage hybrid solid state high performance suppression system.

c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: Provide unit with external terminal screws for line and ground conductors.

2. Operating voltage: 24 Vdc or 24 Vac or 120 Vac or as indicated on the Drawings.
3. Modes of protection: All modes:
   a. AC applications: L-N, L-G, N-G
   b. DC applications: Pos-Neg, Pos-Gnd, Neg-Gnd.
4. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
   a. The SPD shall meet one (1) of the following:
      1) 1000 occurrences of a 200A, 10 x 1000 microsecond waveform.
      2) 400 occurrences of a 500A, 10 x 1000 microsecond waveform.
      3) 100 occurrences of a 400A, 10 x 700 microsecond waveform.
      4) 100 occurrences of a 2000A, 8 x 20 microsecond waveform.
      5) 10 occurrences of a 10,000A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L (Pos-Neg):
   a. The SPD shall meet one (1) of the following:
      1) 400A, 10x700 microsecond waveform: 400 percent of system voltage.
      2) 10,000A, 8x20 microsecond waveform: 400 percent of system voltage.
      3) IEEE B3 combination wave: 250 percent of system voltage.
8. Maximum clamping voltages, L-G:
   a. The SPD shall meet one (1) of the following:
      1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
      2) 10,000A, 8x20 microsecond waveform: 200 percent of system voltage.
      3) IEEE B3 combination wave: 300 percent of system voltage.

2.5 SOURCE QUALITY CONTROL

A. Performance tests to be performed or independently verified by a certified testing laboratory.

B. The SPD are to be tested as a complete SPD system including: Integral unit level and/or component level fusing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type IC1 SPD:
1. Provide on the following applications:
   a. Line side of 120 V power terminals in panels with PLC components.
2. Connected in series with the panel's or equipment’s branch circuit.
3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

C. Type IC3 SPD:
1. Provide on the following applications:
   a. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
   b. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors and the control conductors are routed above grade or underground.

2. Connected in series with the equipment.
3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

D. Type IC7 SPD:
1. Provide on the following applications:
   a. Low voltage (e.g., 24 Vac, 24 Vdc) discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
   b. Low voltage (e.g., 24 Vac, 24 Vdc) discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors and the control conductors are routed above grade or underground.
2. Connect in series with the equipment.
3. Flange mount or DIN rail mount in control panel.
4. Connect all SPDs in the control panel to the same grounding point.

END OF SECTION

2014/08/28

SECTION 13500
PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Programmable logic controller (PLC) control system(s), including software, programming, and training.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 11005 - Equipment: Basic Requirements.
   5. Section 13440 - Instrumentation for Process Control: Basic Requirements.
   6. Section 13441 - Control Loop Descriptions.
   7. Section 13446 - Control Auxiliaries.
   8. Section 13448 - Control Panels and Enclosures.
   9. Section 16120 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.90.2, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
      b. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 1, General Standards for Industrial Control and Systems.

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and startup of at least three (3) similar installations.
   2. Programmer(s) shall have had experience in programming PLCs for at least two (2) projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Product technical data including:
      a. Annotated hard copies of PLC software programs.
         1) Submit program for logic in ladder diagram format as used for the specific PLC system.
         2) Annotate program listing to include the following:
            a) Written description of each rung's function.
            b) Reference to control loop number for each rung where applicable.
            c) Reference to instrumentation tag number of I/O devices for each rung where applicable.
         3) Provide written descriptions completely defining all function blocks used in program.

4) Provide list of all addresses referenced in logic diagram with description of data associated with each address.

b. Results of factory testing procedures.

c. Drawings containing the following information to be submitted as part of Specification Section 13448 submittals:

1) Arrangement Drawings for PLC system components.

2) Panel and enclosure plans, sections and details.

3) Access opening locations and required clearances for each panel and enclosure.

4) Enclosure internal wiring and terminal blocks.

d. Catalog cut sheets containing information on PLC components to be submitted as part of this Specification Section submittals.

B. Miscellaneous Submittals:

1. Certifications:

a. Qualifications of installation supervisor.

b. Qualifications of programmer(s).

C. Operation and Maintenance Manuals:

1. See Specification Section 01342 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. Submit maintenance procedures available to Owner.

a. Include the location and phone numbers of service centers (including 24 HR "hot lines").

b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rockwell Automation, Allen-Bradley.

2. No “or equals” acceptable.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Section 13440.

B. The PLC system shall accomplish the control requirements of the loop descriptions, Drawings, and Specifications.

C. PLC programming shall be documented and factory tested.

D. The PLC system shall operate in ambient conditions of 32 to 140 DegF temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

E. Environmental Controls:

1. Furnish circulation fans in solid state control system enclosures.

F. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of any one (1) component does not affect equipment on all trains.

1. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.

2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common system), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one (1) I/O module does not affect all of the parallel operating equipment units.

G. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

H. Incorporate the following minimum safety measures:
   1. Watchdog function to monitor:
      a. Internal processor clock failure.
      b. Processor memory failure.
      c. Loss of communication between processor and I/O modules.
      d. Processor ceases to execute logic program.
   2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
   3. Safe wiring:
      a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
      b. Low voltage control signal wires:
         1) Place in conduit segregated for that purpose only.
         2) Twisted shielded wire pair.
         3) Not located in the same conduit or bundle with power wiring.
   4. Initial safety conditions:
      a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
      b. Utilize program each time PLC is re-initiated and the control program activated.
   5. Monitoring of internal faults and display:
      a. Internal PLC system status and faults shall be monitored and displayed.
         1) Monitored items shall include:
            a) Memory ok/loss of memory.
            b) Processor ok/processor fault.
            c) Scan time overrun.
   6. Control of programs: Protect access to PLC program loading with password protection or with locked, key operated selector switches.
   7. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.

2.3 COMPONENTS

A. PLC System Central Processor Unit (CPU):
   1. Rockwell Automation ControlLogix.
   2. CPU shall provide communications with other control systems and man-machine interfaces as specified.
   3. Memory:
      a. Non-volatile memory.
   4. Plug-in card design to allow quick field replacement of faulty devices.
      a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
   5. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.
   6. Capable of executing all control functions required by the Specifications and Drawings.

7. Built-in three-mode (proportional-integral-derivative) control capabilities.
    a. As directly selectable algorithms requiring no user knowledge of programming languages.
8. On-line reconfigurable.
9. Lighted status indicators for "RUN" and "FAILURE."
10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
    a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:
1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
    a. I/O solid state boards with status lights indicating I/O status.
    b. Electric isolation between logic and field device.
    c. Capability of withstanding low energy common mode transient to 1000 V without failure.
    d. Incorporate noise suppression design.
    e. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
    f. Install 20 percent spare I/O points (in addition to points listed in PLC Points list at end of this section).
3. Input/output connection requirements:
    a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
    b. Prewire I/O modules to terminal blocks.
    c. Provide terminal blocks with continuous marking strip.
    d. Size terminals to accommodate all active data base points and spares.
    e. Provide terminals for individual termination of each signal shield.
    f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
    a. Interface to ON/OFF devices.
    b. I/O status indicator on module front.
    c. Voltage rating to match circuit voltage.
    d. Output module current rating:
        1) Match maximum circuit current draw.
        2) Minimum 1.0 continuous A/point for 120 Vac applications.
    e. Isolated modules for applications where one (1) module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
    a. Provide one (1) fuse per common or per isolated output.
    b. Provide blown fuse indication.
    c. External fusing shall be provided if output module does not possess internal fusing.
    d. Fuses provided external to output model shall:
        1) Be in accordance with module manufacturer's specifications.
        2) Be installed at terminal block.
6. Analog I/O modules:
    a. Input modules to accept signals indicated on Drawings or Specifications.
    b. Minimum 12 bit resolution.
    c. I/O chassis supplied power for powering connected field devices.
    d. Differential inputs and outputs.
    e. User configurable for desired fault-response state.
    f. Provide output signals as indicated on Drawings and Specifications.
    g. Individual D/A converter for each output module.
    h. Individual A/D converter for each input module.

C. Power Supply Units:
   1. Provide regulated power units:
      a. Designed to operate with PLC system and shall provide power to:
         1) All components of PLC system.
         2) All two-wire field instruments.
         3) Other devices as indicated on Drawings or Specifications.
      b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
      c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.
   2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1 percent, 1 PH power.
   3. Separate AC circuit breakers shall be provided for each power supply.
   4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
   5. Power distribution:
      a. Immune to transients and surges resultant from noisy environment.
      b. Shall provide constant voltage level DC distribution to all devices.
   6. Provide uninterruptible power supply (UPS) in accordance with Section 13446 to sustain full power to UPS powered loads listed below for a minimum of 15minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
      a. UPS powered loads:
         1) All rack mounted PLC components.
         2) Local operator consoles.
         3) All power supplies furnished with the PLC and associated loads.

D. PLC System Enclosure:
   1. In accordance with Section 13448.
   2. Component placement:
      a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.
      b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
      c. Do not place I/O racks directly above the CPU or power supply.
      d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
      e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
      f. Place circulating fans close to major heat generating devices.
      g. Segregate input/output modules into groups of identical type.
   3. Wiring and grounding to be in accordance with Section 13448.
   4. Termination requirements:
      a. In accordance with Section 13448.
      b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
      c. Prewire I/O modules to terminal blocks.
      d. Size terminals to accommodate all active database points and spares.
      e. Provide terminals for individual termination of each signal shield.
      f. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:
   1. Provide all hardware and programming required to provide communication between the PLC and the man-machine interface.

2. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
3. Provide two (2) copies of control logic program on 3-1/2 IN disks or on CD.
4. Full documentation capability.
    a. Provide description for each rung.
5. On/off line programming.

2.4 ACCESSORIES

A. Provide all accessories required to furnish a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

2.5 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
    1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
    2. Conduct testing with dummy I/Os to verify each control loop operation.
    3. Allow for Owner and Engineer representatives to witness testing program.
        a. Provide minimum of 15 days notice prior to testing.
    4. Do not ship prior to successful completion of this testing program.

2.6 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra materials:
    1. One (1) spare I/O card of each card type for every 10 cards or fraction thereof installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
    1. Inspect equipment covered by these Specifications.
    2. Supervise adjustments and installation checks.
    3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
        a. All commissioning functions may be witnessed by the Engineer.
        b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
    4. Conduct startup of equipment and perform operational checks.
    5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.3 DEMONSTRATION

A. Demonstrate system in accordance with Section 01650.

B. On-Site Training:
    1. Provide employee of the manufacturer or certified representative to provide one (1) day of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
        a. As a minimum, training shall cover:
            1) Hardware overview.
            2) Software overview.
            3) Maintenance.
            4) Trouble shooting.

5) Operation, e.g., changing set points, passwords, etc.

3.4 PLC I/O POINTS LIST

ANALOG INPUTS – COLLECTOR WELL PLC

No.	TAG	DESCRIPTION	FROM
1.	FI-01	CWP-01 discharge flow rate	FIT-01
2.	SI-01	CWP-01 pump speed	VFD
3.	FI-02	CWP-02 discharge flow rate	FIT-02
4.	SI-02	CWP-02 pump speed	VFD
5.	FI-03	CWP-03 discharge flow rate	FIT-03
6.	SI-03	CWP-03 pump speed	VFD
7.	FI-04	Future CWP-04 discharge flow rate	Future FIT-04
8.	SI-04	Future CWP-04 pump speed	Future VFD
9.	PI-05	Collector Well Pump discharge pressure	PIT-05
10.	LI-06	Collector Well level	LT-06

ANALOG OUTPUTS – COLLECTOR WELL PLC

No.	TAG	DESCRIPTION	TO
1.	FIC-01/SIC-01	CWP-01 pump speed control	VFD
2.	FIC-02/SIC-02	CWP-02 pump speed control	VFD
3.	FIC-03/SIC-03	CWP-03 pump speed control	VFD
4.	FIC-04/SIC-04	Future CWP-04 pump speed control	Future VFD

DISCRETE INPUTS – COLLECTOR WELL PLC

No.	TAG	DESCRIPTION	FROM
1.	KI-01	CWP-01 in pre-lube time sequence	VFD
2.	PAH-01	CWP-01 discharge high pressure alarm	VFD
3.	TAHH-01	CWP-01 motor temperature high-high	VFD
4.	XA-01B	CWP-01 VFD Fault	VFD
5.	YI-01	CWP-01 run status	VFD
6.	ZCI-01	CWP-01 discharge valve closed status	VFD
7.	ZI-01	CWP-01 in Remote mode	VFD
8.	KI-02	CWP-02 in pre-lube time sequence	VFD
9.	PAH-02	CWP-02 discharge high pressure alarm	VFD
10.	TAHH-02	CWP-02 motor temperature high-high	VFD
11.	XA-02B	CWP-02 VFD Fault	VFD
12.	YI-02	CWP-02 run status	VFD
13.	ZCI-02	CWP-02 discharge valve closed status	VFD
14.	ZI-02	CWP-02 in Remote mode	VFD
15.	KI-03	CWP-03 in pre-lube time sequence	VFD
16.	PAH-03	CWP-03 discharge high pressure alarm	VFD
17.	TAHH-03	CWP-03 motor temperature high-high	VFD
18.	XA-03B	CWP-03 VFD Fault	VFD
19.	YI-03	CWP-03 run status	VFD
20.	ZCI-03	CWP-03 discharge valve closed status	VFD
21.	ZI-03	CWP-03 in Remote mode	VFD
22.	KI-04	Future CWP-04 in pre-lube time sequence	Future VFD
23.	PAH-04	Future CWP-04 discharge high pressure alarm	Future VFD
24.	TAHH-04	Future CWP-04 motor temperature high-high	Future VFD
25.	XA-04B	Future CWP-04 VFD Fault	Future VFD

No.	TAG	DESCRIPTION	FROM
26.	YI-04	Future CWP-04 run status	Future VFD
27.	ZCI-04	Future CWP-04 discharge valve closed status	Future VFD
28.	ZI-04	Future CWP-04 in Remote mode	Future VFD
29.	XA-07A	PLC Control Panel UPS trouble alarm	UPS in Control Panel
30.	XA-07B	PLC Control Panel UPS on battery	UPS in Control Panel
31.	XA-08	Switchgear MSB-01 surge protection device alarm	Switchgear MSB-01
32.	XA-09	Collector Well smoke detected	Smoke detector
33.	ZA-50	Door intrusion alarm	ZS-50
34.	HS-50	Door intrusion alarm bypass	HS-50
35.	ZA-51	North roof hatch intrusion alarm	ZS-51
36.	ZA-52	South roof hatch intrusion alarm	ZS-52
37.	ZA-53	Valve level hatch intrusion alarm	ZS-53

DISCRETE OUTPUTS – COLLECTOR WELL PLC

No.	TAG	DESCRIPTION	TO
1.	HS-01	CWP-01 start/stop control	VFD
2.	HS-02	CWP-02 start/stop control	VFD
3.	HS-03	CWP-03 start/stop control	VFD
4.	HS-04	Future CWP-04 start/stop control	Future VFD

DISCRETE INPUTS – REMOTE I/O PANEL

No.	TAG	DESCRIPTION	FROM
1.	YI-10	Generator run status	Generator CP
2.	XA-10A	Generator trouble alarm	Generator CP
3.	XA-10B	Generator fail alarm	Generator CP
4.	LAL-10	Generator low fuel alarm	Generator CP
5.	ZI-11A	Collector Well on Utility Power (Main Utility Breaker closed)	Switchgear PDP01
6.	ZI-11B	Collector Well on Generator Power (Generator Breaker closed)	Switchgear PDP01
7.	XA-11	Switchgear surge protection device alarm	Switchgear PDP01
8.	XA-12A	Remote I/O Panel UPS trouble alarm	UPS in Remote I/O Panel
9.	XA-12B	Remote I/O Panel UPS on battery	UPS in Remote I/O Panel

END OF SECTION

2014/08/28

SECTION 13502
COMPUTER NETWORK AND HUMAN MACHINE INTERFACE (HMI) HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Computer network and HMI hardware requirements which includes but is not necessarily limited to:
      a. Panel mounted OIT (Operator Interface Terminals).
      b. Ethernet switches.
      c. Software.
      d. Accessories and maintenance materials.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 DEFINITIONS

A. OIT: Operator Interface Terminal.

B. SNMP: Simple Network Management Protocol, a set of protocols for managing complex networks.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PANEL MOUNTED OPERATOR INTERFACE PANELS (OIT)

A. Acceptable Manufacturers: Allen-Bradley Panel View Plus 6.

B. Design and Fabrication:
   1. Display: color graphics.

2. Touch screen.
3. Communicate via Ethernet to PLC.
4. Provide password protection to prevent unauthorized entries for a minimum of two (2) levels:
    a. Authorization to operate.
    b. Authorization to adjust setpoints.
5. Operating temperature: 32 DegF to 131 DegF.
6. Humidity: 10 to 90 percent RH non-condensing.

C. Configuration software:
1. Utilize Factory Talk View Studio Machine Edition.

D. Schedule:
1. Provide flat face panels on the face of each of the following control panels.

LOCATION	SIZE, INCHES
Collector Well PLC Panel	15

2.3 ETHERNET SWITCHES

A. Acceptable Manufacturers:
1. Hirschmann.
2. Siemens.
3. N-TRON.
4. Allen-Bradley/Cisco.
5. SixNet.

B. Managed Ethernet Switches:
1. Design and fabrication:
    a. Support Ethernet 100 MBit/s.
    b. Provide fiber port where required to communicate via fiber optic cable.
    c. Support SNMP and Web based management.
    d. Rapid Spanning Tree Protocol.
    e. IGMP (Internet Group Management Protocol) support for IP multicast filtering to enable switches to automatically route messages only to appropriate ports.
    f. 10/100 MBit/s twisted pair ports (RJ45) as required for communication with devices as depicted in the Contract Documents.
    g. Check all received data for validity.
        1) Discard invalid and defective frames or fragments.
    h. As applicable, meet requirements of IEEE 802.3.
    i. Provide LED status lights to indicate:
        1) Power: Supply voltage present.
        2) Fault.
        3) Port status.
    j. Environmental rating:
        1) Operating temperature: 32 Deg F to 122 Deg F.
        2) Humidity: 95 percent relative humidity, non-condensing.

C. Fiber Interconnect Panel:
1. Acceptable Manufacturers:
    a. Corning.
    b. Or Equal.
2. Design and fabrication:
    a. Furnish LC style multi mode adapter for each port.
    b. Adapter panels shall snap-in for easy installation, removal, and expansion.
    c. Open access with single door and latch.

d. Complete internal cable management with designation lables for proper cable administration.
e. Provide easy access for installer to terminate cables.

2.4 SOFTWARE

A. Provide all software and associated programming/configuration required to meet performance requirements of the Contract Documents.
   1. At substantial completion of the Project:
      a. Turn current licenses for all software over to the Owner in the Owner's name and install the latest version, upgrade or service pack for all software.

B. All software must be latest edition and licensed to the Owner.

2.5 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01650.

3.2 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Specification Section 13440.

END OF SECTION

1

2014/08/14

SECTION 13504

CONFIGURATION REQUIREMENTS: HUMAN MACHINE INTERFACE (HMI) AND REPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Configuration requirements for HMI and reports which includes but is not necessarily limited to.
      a. Specific software functional descriptions.
      b. Graphics requirements.
      c. HMI functionality requirements.
      d. Plant overview screens.
      e. Process overview screens.
      f. Detail displays.
      g. Trend displays.
      h. PLC hardware/HMI status screen.
      i. Alarm monitoring.
      j. Report generation.
      k. Configuration standards and conventions.
      l. Screen configuration review meetings.
      m. Report configuration review meetings.
      n. Coordination.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 13440 - Instrumentation for Process Control: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Programmer(s) shall have had experience in software configuration and installation for at least two (2) projects of similar size and complexity.

1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. I/O: Input/Output.

C. OLE: Object Linking and Embedding, a document standard developed by Microsoft that enables the creation of an object with one application and the linking or embedding of the object in a second application.

D. OPC: "OLE for Process Control"; a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

E. PC: Personal Computer.

F. PLC: Programmable Logic Controller.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Software Configuration Standards and Conventions document.
   4. Graphic screen displays; provide in actual colors utilized.
   5. Sample reports.
   6. Certifications:
      a. Qualifications of programmer(s).

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Software Configuration Standards and Conventions - final version.

C. Informational Submittals:
   1. Results of factory testing procedures.
   2. Proposed training agendas and schedule.

1.5 GENERAL FUNCTIONAL REQUIREMENTS

A. Software Functional Requirements:
   1. General functional requirements for system configuration are indicated on the Drawings and described in the Specifications.
   2. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system.
   3. The Contractor is responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Owner.

B. Available Process Values:
   1. All process alarm, equipment status, and process variable values shall be available at any HMI.
   2. If communications to a particular I/O point has failed for any reason, then wherever that data is displayed, the software shall post a visual indication that the point is not valid.

C. Provide comprehensive on-line help for all development functions.

D. Manual Entry of Data:
   1. All PC-based HMIs must allow manual entry of surrogate data and other variables, which must then be available for display and use in reports.
      a. Operator-entered commands from any of the operator workstations must be logged by the computer servers.

E. System Failure:
   1. Failure of any PLC, remote I/O hardware, or network communication link must be individually alarmed at HMIs.
   2. Unless otherwise specified, each alarm must be specific to a single point of failure.

F. All process related functions, calculations, timers, and numeric manipulations, shall be accomplished in the PLC hardware and not in the HMI.
   1. The HMI shall function as a monitoring system, not as a process controller.
   2. The HMI shall transfer data to the PLC system and the PLC system shall perform all control algorithms.

1.6 SECURITY

A. Fully integrate security into the SCADA system to allow only users with appropriate security levels access to individual parts of the system.

PART 2 - PRODUCTS

2.1 SPECIFIC SOFTWARE FUNCTIONAL DESCRIPTIONS

A. Specific functional requirements for various software control blocks within the computer system are as follows.

B. Descriptions are general and are not intended to fully indicate the complete functionality of the system.
   1. Monitoring of process values:
      a. Process values derived from analog process variable signals must be historically archived.
         1) Store all historical data with time and date of occurrence.
         2) Make values available for use in reports.
         3) Assign high and low alarms to process values as defined below and otherwise deemed appropriate.
      b. Provide capability for computer server(s) to retrieve real-time values from the PLC system at adjustable time periods.
      c. Alarm limits:
         1) Set per direction from the Owner.
         2) An operator having proper security authorization must be able to enable, disable, and adjust the setpoint of any individual alarm.

C. Utilize graphic screen displays at the OIT and HMI(s) to provide monitoring and control functionality.
   1. Hierarchy of HMI screens is in descending order as follows:
      a. Plant overview screen(s).
      b. Process overview screens.
      c. Process screens.
      d. Pop-up/control screens.

D. OIT and HMI operator interface functionality shall include:
   1. Indication of process variables.
   2. Configuration of control loop parameters (e.g., setpoints, gains, etc.).
   3. Adjustment of controller output.
   4. Display of real time and historical process trends.
   5. Selector switch and pushbutton station controls.
   6. System and process status indicators.
   7. Graphic representation of plant operations with interactive status and measurement symbols.
   8. Annunciation.

E. Graphics:
   1. Match the existing graphic screen format, functionality, and appearance to the maximum extent practical.
   2. Utilize dynamic variables with unique tags per graphic.
   3. All monitored and or controlled process equipment shall be animated or color-highlighted to indicate status changes.

F. Trend Displays:
   1. Real time historical trend displays.
   2. Real time on-line trend displays.
   3. Capable of displaying multiple points per display.
   4. Operator shall be able to select any desired sample time interval.

5. Provide flexibility and easy access to real time and historical trend information for any variable TAG defined within the SCADA application.

G. PLC Hardware/HMI Status Screen:
1. Provide a status screen to depict status conditions and diagnostic information for all major networked equipment.
2. Depict communication status for all networked communicating devices, such as PLC processors, Ethernet switches, PCs, and radios.

H. Alarm Monitoring:
1. Provide standard alarm screen functionality to ensure flexibility and quick access to live alarms, alarm history and alarm grouping parameters.
2. Analog alarms:
a. The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition.
b. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
1) Low-low.
2) Low.
3) High.
4) High-high.
5) Deviation low.
6) Deviation high.
7) Rate of change.
c. Provide adjustable dead bands and delay timers for all analog alarms.
3. Present alarms in order of:
a. Priority.
b. Time of occurrence.
c. Non-acknowledged presented ahead of acknowledged.
4. Utilize single keystroke or pushbutton to:
a. Acknowledge alarms.
5. Alarm list presented to operator shall include:
a. Time of occurrence.
b. Time of acknowledgement.
c. Description.
d. Acknowledgement status.

2.2 SOURCE QUALITY CONTROL

A. Include performance test of OIT software in factory with the overall PLC System test.
1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
2. Allow for Owner and Engineer representatives to witness testing program.
a. Provide minimum of 15 days notice prior to testing.

PART 3 - EXECUTION

3.1 CONFIGURATION REQUIREMENTS

A. Provide all programming and configuration required for all HMIs furnished under this Contract:

3.2 CONFIGURATION STANDARDS AND CONVENTIONS

A. Prepare and submit a "Software Configuration Standards and Conventions."
1. Submit for review and approval prior to commencing with software configuration.
2. Describe and define such items as:
a. Proposed graphic display process colors/representations.

b. Color standards for "ON," "OFF," and "ALARM" conditions.
c. Font type and size.
d. Alarm handling conventions.
e. Methods for navigation between displays.
f. Address usage/naming conventions.
g. Security setup.

3. Prior to submitting the initial draft document, the Contractor must meet with the Owner to review any of the Owner's existing standards and conventions.
4. In addition to submitting the initial document for review, submit an updated version of the document as part of the Operation and Maintenance Manuals.
   a. Revise this document to include any additional standards that are established throughout the configuration process.

3.3 SCREEN CONFIGURATION REVIEW MEETINGS

A. Conduct a minimum of one configuration conference with the Owner to review and discuss system configuration programming and related topics.
   1. The purpose of the conference will be to discuss, in detail, how each I/O point will be handled and the types, quantities, hierarchies, and functioning of display screens.
   2. Review of the Owner's existing systems, standards, conventions, file and tag naming requirements, font type and size requirements, and reporting requirements must be part of each conference.
   3. Review the navigation bar to be utilized.
   4. Conferences will be held at the Water Treatment Plant.
   5. Each screen will be reviewed at each conference.
      a. If required, to review all screens, each conference will occur on multiple days.
   6. Submit five (5) color copies of printed screens via shop drawing submittal process 10 calendar days before each conference.
   7. Bring equipment to project screens on wall or provide multiple monitors for viewing by attendees.

B. Proposed graphic screens and report formats must be reviewed with the Owner throughout the configuration process.

3.4 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Engineer.
      b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.5 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01650.

END OF SECTION

1

DIVISION 15

MECHANICAL

2014/10/07

SECTION 15060
PIPE AND PIPE FITTINGS: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Process piping systems.
2. Utility piping systems.
3. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 02221 - Trenching, Backfilling, and Compacting for Utilities.
4. Section 09905 - Painting and Protective Coatings.
5. Section 10400 - Identification Devices.
6. Section 11005 - Equipment: Basic Requirements.
7. Section 13442 - Primary Elements and Transmitters.
8. Section 15090 - Pipe Support Systems.
9. Section 15100 - Valves: Basic Requirements.
10. Section 15183 - Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760).
b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
d. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
2. American Iron and Steel Institute (AISI).
3. American Society of Mechanical Engineers (ASME):
a. B16.3, Malleable Iron Threaded Fittings.
b. B16.5, Pipe Flanges and Flanged Fittings.
c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
f. B36.19, Stainless Steel Pipe.
g. B40.100, Pressure Gauges and Gauge Attachments.
4. ASTM International (ASTM):
a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
c. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
e. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
f. A197, Standard Specification for Cupola Malleable Iron.

g. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
h. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
i. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
j. A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
k. A536, Standard Specification for Ductile Iron Castings.
l. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
m. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
n. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
o. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
p. B88, Standard Specification for Seamless Copper Water Tube.
q. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
r. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
s. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
t. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
u. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
v. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
w. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
x. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
y. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
aa. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
bb. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

5. American Water Works Association (AWWA):
   a. B300, Standard for Hypochlorites.
   b. C200, Standard for Steel Water Pipe - 6 IN and Larger.
   c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
   d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   e. C606, Standard for Grooved and Shouldered Joints.
   f. C651, Standard for Disinfecting Water Mains.
   g. C800, Standard for Underground Service Line Valves and Fittings.
6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.
7. Chlorine Institute, Inc. (CI):
a. Pamphlet 6, Piping Systems for Dry Chlorine.
8. Cast Iron Soil Pipe Institute (CISPI):
a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
9. International Plumbing Code (IPC).
10. National Fire Protection Association (NFPA):
a. 54, National Fuel Gas Code.
b. 69, Standard on Explosion Prevention Systems.
11. Underwriters Laboratories, Inc. (UL).

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.3 SYSTEM DESCRIPTION

A. Piping Systems Organization and Definition:
1. Piping services are grouped into designated systems according to the chemical and physical properties of the fluid conveyed, system pressure, piping size and system materials of construction.
2. See PIPING SPECIFICATION SCHEDULES in PART 3.
3. The table below identifies each service classification, its symbol, the designated system number for each service, and when the installation of a tracer wire is required:

SYSTEM	SYMBOL	SYSTEM NO.	TRACER WIRE
Raw Water Transmission Main Piping	RWTM	2	
Collector Well Pump Discharge	CWPDIS	2	
Condenser Water Supply	CWS	6	
Condenser Water Return	CWR	6	
Raw Water Supply	RWS	6	
Raw Water Return	RWR	6	
Pre-Lube	PL	7	
Air Release/Vacuum Valve Vent	ARVV	7	
Vent	V	7	

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
c. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
1) Attach technical product data on gaskets, pipe, fittings, and other components.

3. Fabrication and/or layout Drawings:
    a. Exterior yard piping Drawings (minimum scale 1 IN equals 10 FT) with information including:
        1) Dimensions of piping lengths.
        2) Invert or centerline elevations of piping crossings.
        3) Acknowledgement of bury depth requirements.
        4) Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.
        5) Acknowledge designated valve or gate tag numbers, manhole numbers, instrument tag numbers, pipe and line numbers.
        6) Line slopes and vents.
    b. Interior piping Drawings (minimum scale 1/8 IN equals 1 FT) with information including:
        1) Dimensions of piping from column lines or wall surfaces.
        2) Centerline dimensions of piping.
        3) Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.
        4) Location and type of pipe supports and anchors.
        5) Locations of valves and valve actuator type.
        6) Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
        7) Acknowledgement of valve, equipment and instrument tag numbers.
        8) Provisions for expansion and contraction.
        9) Line slopes and air release vents.
        10) Rough-in data for plumbing fixtures.
    c. Schedule of interconnections to existing piping and method of connection.

B. Operation and Maintenance Manuals:
    1. See Specification Section 01342 for requirements for:
        a. The mechanics and administration of the submittal process.
        b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
    1. Qualifications of lab performing disinfection analysis on water systems.
    2. Test reports:
        a. Copies of pressure test results on all piping systems.
        b. Reports defining results of dielectric testing and corrective action taken.
        c. Disinfection test report.
        d. Notification of time and date of piping pressure tests.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe coating during handling using methods recommended by manufacturer.
    1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent Damage to Pipe During Transit.
    1. Repair abrasions, scars, and blemishes.
    2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Insulating unions:
        a. "Dielectric" by Epco.

b. Central.
2. Dirt strainers (Y type):
a. Mueller (#351).
b. Sarco.
c. Armstrong.
3. Chemical strainers (Y type):
a. Chemtrol.
b. Asahi.
4. Dry disconnect couplings:
a. Kamlock.
5. Dielectric flange kit:
a. PSI.
b. Maloney.
c. Central Plastics.
6. Pipe saddles (for gage installation):
a. Dresser Style 91 (steel and ductile iron systems).
b. Dresser Style 194 (nonmetallic systems).
7. Rubber expansion joints (REJ):
a. Mercer Rubber Company.
b. Unaflex, Inc.
8. Non-shear couplings:
a. Power Seal Pipeline Products Corp., Power Steel Model 3541.
b. Repair Coupling Fernco, Inc., Strong back RC Series.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PIPING SPECIFICATION SCHEDULES

A. Piping system materials, fittings and appurtenances are subject to requirements of specific piping specification schedules located at the end of PART 3 of this Specification Section.

2.3 COMPONENTS AND ACCESSORIES

A. Insulating Components:
1. Dielectric flange kits:
a. Flat faced.
b. 1/8 IN thick dielectric gasket, phenolic, non-asbestos.
c. Suitable for 175 psi, 210 DegF.
d. 1/32 IN wall thickness bolt sleeves.
e. 1/8 IN thick phenolic insulating washers.
2. Dielectric unions:
a. Screwed end connections.
b. Rated at 175 psi, 210 DegF.
c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

B. Dirt Strainers:
1. Y-type.
2. Composition bronze.
3. Rated for test pressure and temperature of system in which they are installed.
4. 20 mesh Monel screen.
5. Threaded bronze plug in the blowoff outlet.
6. Threaded NPT end connections.

C. Reducers:
1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

D. Protective Coating and Lining:
   1. Include pipe, fittings, and appurtenances where coatings, linings, paint, tests and other items are specified.
   2. Field paint pipe in accordance with Specification Section 09905.

E. Underground Warning Tape: See Specification Section 10400.

F. Pressure Gages:
   1. See Specification Section 11005 and Specification Section 13442.

G. Valves:
   1. See schematics and details for definition of manual valves used in each system under 4 IN in size.
      a. See Specification Section 15100 schedule for valve types 4 IN and above and for automatic valves used in each system.
   2. See Specification Section 15100.

PART 3 - EXECUTION

3.1 EXTERIOR BURIED PIPING INSTALLATION

A. Unless otherwise shown on the Drawings, provide a minimum of 7 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.

B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01800 and as shown on Drawings.

C. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
   1. Install second joint not more than 6 FT nor less than 4 FT from first joint.

D. Install expansion devices as necessary to allow expansion and contraction movement.

E. Laying Pipe In Trench:
   1. Excavate and backfill trench in accordance with Specification Section 02221.
   2. Clean each pipe length thoroughly and inspect for compliance to specifications.
   3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
   4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
   5. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
   6. Lay pipe in only suitable weather with good trench conditions.
      a. Never lay pipe in water except where approved by Engineer.
   7. Seal open end of line with watertight plug if pipe laying stopped.
   8. Remove water in trench before removal of plug.

F. Lining Up Push-On Joint Piping:
   1. Lay piping on route lines shown on Drawings.
   2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
   3. Observe maximum deflection values stated in manufacturer's written literature.
   4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
   5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

G. Anchorage and Blocking:
   1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.

2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
    a. Concrete blocks shall not cover pipe joints.
3. Provide bearing area of concrete in accordance with drawing detail.

H. Install underground hazard warning tape per Specification Section 10400.

I. Install insulating components where dissimilar metals are joined together.

3.2 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01800 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:
1. Use methods of piping support as shown on Drawings and as required in Specification Section 15090.
2. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
    a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
3. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.
1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Use reducing fittings throughout piping systems.
1. Bushings will not be allowed unless specifically approved.

H. Equipment Drainage and Miscellaneous Piping:
1. Provide drip pans and piping at equipment where condensation may occur.
2. Hard pipe stuffing box leakage to nearest floor drain.
3. Avoid piping over electrical components such as motor control centers, panelboards, etc.
    a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
    b. Hard pipe drainage to nearest floor drain.
4. Collect system condensate at drip pockets, traps and blowoff valves.
5. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.
6. For applications defined above and for other miscellaneous piping which is not addressed by a specific piping service category in PART 1, provide 304 stainless steel piping and fittings.
    a. Size to handle application with 3/4 IN being minimum size provided.

I. Unions:
1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
2. Mechanical type couplings may serve as unions.
3. Additional flange unions are not required at flanged connections.

J. Install expansion devices as necessary to allow expansion/contraction movement.

K. Provide full face gaskets on all systems.

L. Anchorage and Blocking:
   1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

M. Equipment Pipe Connections:
   1. Equipment - General:
      a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
      b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
      c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
         1) Provide tightening torque in accordance with manufacturer's recommendations.
      d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
      e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
      f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
      g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
      h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
         1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
         2) Realign as necessary, install flange bolts and make equipment connection.
      i. Provide utility connections to equipment shown on Drawings, scheduled or specified.
   2. Plumbing and HVAC equipment:
      a. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
      b. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
      c. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
         1) Provide wheel handle stop valve at each laboratory sink water supply.
         2) Minimum size: 1/2 IN.
      d. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
         1) Size trap as required by IPC.
      e. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

N. Provide insulating components where dissimilar metals are joined together.

O. Instrument Connections: See Drawing details.

3.3 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.

C. Undertake connections in fashion which will disturb system as little as possible.

D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.4 ACCESS PROVISIONS

A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.

B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.

C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.

D. Provide with key locks, keyed alike, in public use areas.

E. Furnish panels with prime coat of paint.

F. Style and type as required for material in which door installed.

G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.5 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Make all connections from wire or cable by Thermit Cadwelding accomplished by operators experienced in this process.

C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 percent of the straight line length.

D. After cadwelding, coat all exposed metallic surfaces with hot applied tape.

3.6 PRESSURE GAGES

A. Provide at locations shown on the Drawings and specified.

B. See Specification Section 11005.

3.7 FIELD QUALITY CONTROL

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.

2. Utilize pressures, media and pressure test durations as specified in the PIPING SPECIFICATION SCHEDULES.
3. Isolate equipment which may be damaged by the specified pressure test conditions.
4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
   a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
   b. Notify the Engineer 24 HRS prior to each test.
5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
6. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
1. Testing medium: Unless otherwise specified in the PIPING SPECIFICATION SCHEDULES, utilize the following test media.
   a. Liquid systems:

PIPE LINE SIZE (DIA)	GRAVITY OR PUMPED	SPECIFIED TEST PRESSURE	TESTING MEDIUM
Up to and including 48 IN	Gravity	25 psig or less	Air or water
All sizes	Pumped	250 psig or less	Water

2. Allowable leakage rates:
   a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.
   b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
      1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
      2) Average head is defined from groundwater elevation to average pipe crown.
      3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) equals 115 by (actual test head to the 1/2 power).
   c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
      1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
      2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 by (actual head to the 1/2 power).
   d. Large diameter (above 48 IN) gravity plant piping systems shall have a maximum exfiltration of 25 gpd per inch-mile.
   e. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 percent of the specified test pressure throughout the duration of the test.
   f. For low pressure (less than 25 psig) air testing, the acceptable time for loss of 1 psig of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
4	0.3
6	0.7
8	1.2

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3
48	7.6

3. Hydrostatic pressure testing methodology:
    a. General:
        1) All joints, including welds, are to be left exposed for examination during the test.
        2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
        3) Provide temporary restraints for expansion joints for additional pressure load under test.
        4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
        5) Do not paint or insulate exposed piping until successful performance of pressure test.
    b. Soil, waste, drain and vent systems:
        1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
        2) Eliminate leaks before proceeding with work or concealing piping.
        3) Minimum test heights shall be 10 FT above highest stack inlet.
    c. Larger diameter (above 36 IN) gravity plant piping:
        1) Plug downstream end of segment to be tested.
            a) Provide bracing as required.
        2) Fill segment and upstream structure to normal operating level as per hydraulic profile.
        3) Allow 24 HRS for absorption losses.
            a) Refill to original level.
        4) Provide reservoir to maintain constant head over duration of test.
        5) Record reservoir water volume at beginning and end of test.
4. Natural gas systems - testing methodology:
    a. Maintain specified test pressure until each joint has been thoroughly examined for leaks by means of soap suds and glycerine.
    b. Wipe joints clean after test.
5. Air testing methodology:
    a. General:
        1) Assure air is ambient temperature.
    b. Low pressure air testing:
        1) Place plugs in line and inflate to 25 psig.
        2) Check pneumatic plugs for proper sealing.
        3) Introduce low pressure air into sealed line segment until air pressure reaches 4 psig greater than ground water that may be over the pipe.
            a) Use test gage conforming to ASME B40.100 with 0 to 15 psi scale and accuracy of 1 percent of full range.
        4) Allow 2 minutes for air pressure to stabilize.

5) After stabilization period (3.5 psig minimum pressure in pipe) discontinue air supply to line segment.
6) Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:
1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.8 CLEANING, DISINFECTION AND PURGING

A. Cleaning:
1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
6. After erection of piping and tubing, but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter by means of air, nitrogen or carbon dioxide.
a. Oxygen shall never be used.
7. Clean chlorine piping in accordance with CI Pamphlet 6.
8. Purge all neat liquid polymer tubing or piping between the neat polymer storage tank or tote and the polymer blending units with mineral oil to remove residual water prior to introducing neat polymer. Following purging, drain as much of the mineral oil out of the system as possible. Dispose of purged fluids and waste mineral oil in accordance with local environmental regulations.

B. Disinfection of Potable Water Systems:
1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300.
4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
5. Drain flushing water to sanitary sewer.
a. Do not drain flushing water to receiving stream.
6. Use continuous feed method of application.
a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
a. Repeat entire disinfection procedures until satisfactory results are obtained.

9. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
    a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of South Dakota.

3.9 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

3.10 PIPE INSULATION

A. Insulate pipe and pipe fittings in accordance with Specification Section 15183.

3.11 SCHEDULES

A. SPECIFICATION SCHEDULE - SYSTEM 2
1. General:
a. Piping symbol and service:
1) RWTM – Raw Water Transmission Main Piping.
2) CWPDIS – Collector Well Discharge Piping.
b. Test requirements:
1) Test medium: Water.
2) Pressure: 150 psig.
3) Duration: 6 HRS.
c. Gaskets:
1) Flanged, push-on, and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2. System components:
a. Pipe size 3 IN through 30 IN:
1) Exposed service:
a) Material:
(1) Flanged: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: Paint per Section 09905.
e) Fittings: AWWA/ANSI C110/A21.10 ductile.
f) Joints:
(1) AWWA/ANSI C115/A21.15 flanged joints with flanges at valves and structure penetrations.
(2) Provide restrained flange adapters for one joint at each flanged equipment valve and penetration as shown on the drawings.
2) Buried service:
a) 30 IN
(1) Materials: Ductile iron, pressure class 350.
(2) Reference: AWWA/ANSI C151/A21.51.
(3) Lining: Cement.
(4) Coating: Bituminous.
(5) Fittings:
(a) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(b) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings.
(6) Joints:
(a) Buried Fittings shall be restrained mechanical joint.
(b) Restrained mechanical joints at fittings and valves
(7) Provide Flex-Lok Socket and Flex-Lok Ball Joints at the Collector Well Structure as shown on the drawings.
(8) Polyethylene encasement per AWWA C105.
(9) Warning tape: Tape shall not be in contact with pipe.
b) 24 IN
(1) Materials:
(a) PVC, AWWA C905, DR 18 (C.I.O.D)
(2) Lining: Cement – DIP Fittings
(3) Coating: None.
(4) Corrosion Protection: Polywrap on buried DIP and Fittings.
(5) Fittings:
(a) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(b) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings.
(6) Joints:
(a) Elastomeric-gasket type with a pressure rating not less than the pipe pressure rating meeting performance requirements of ASTM D3139.

(b) Restrained mechanical joints at fittings and valves; EBAA Iron, Series 2000PV or Engineer Approved Equal.

(c) Buried Fittings shall be restrained mechanical joint.

(7) Tracer wire: #12 AWG HS-CCS high-strength, Copper Clad Steel Conductor (HS-CCS), Stainless Steel. 380 LBS average tensile break load with 21% conductivity for locating purposes. Insulation with 30 mil, high-density, high molecular weight polyethylene insulation rated for direct buriel use at 30 V volt. Waterproof connector – 3M DBR, Copperhead SnakeBit or Engineer approved equal. Insulation color shall meet the APWA color code standard for identification of buried utilites.

(8) Transition from DIP to PVC with restrained mechanical joint coupling; EBAA Series 3800 Restained Joint Coupling or Engineer approved equivalent.

B. SPECIFICATION SCHEDULE - SYSTEM 6
   1. General:
      a. Piping symbol and service:
         1) CWR - Condenser Water Return.
         2) CWS - Condenser Water Supply.
         3) RWR - Raw Water Return.
         4) RWS - Raw Water Supply.
      b. Test requirements:
         1) Test medium: Water.
         2) Pressure: 125 psig.
         3) Duration: 6 HRS.
      c. Gaskets and O-rings: EPDM.
   2. System components:
      a. Pipe size through 26 IN:
         1) Exposed service:
            a) Material:
               (1) Threaded: Steel, Grade B, black, Schedule 40.
               (2) Grooved type joint system: Use pipe thickness per AWWA C606.
            b) Reference: ASTM A53.
            c) Lining: None.
            d) Coating: Paint.
            e) Fittings: Malleable iron or steel meeting ASME B16.3 and ASTM A234.
            f) Joints:
               (1) Threaded or grooved type mechanical coupling (AWWA C606) joints.
               (2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.

C. SPECIFICATION SCHEDULE - SYSTEM 7
1. General:
a. Piping symbol and service:
1) PL – Pre-Lube Piping
2) ARVV – Air Release/Vacuum Valve Vent Piping
3) V – Vent Piping.
b. Test requirements pressure lines:
1) Test medium: Water.
2) Pressure: 125 psig.
3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) Flanged, push-on, and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2. System components:
a. Pipe size 6 IN and smaller:
1) Interior Exposed service:
a) Material: PVC, Type 1, Grade 1, Schedule 80.
b) Reference: ASTM D1785.
c) Lining: None.
d) Coating: None.
e) Fittings: Solvent welded (compatable solvent) socket type complying with ASTM D2467.
f) Joints: Solvent welded (compatable solvent) with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
2) Exterior Exposed service:
a) Material:
(1) Flanged: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: Paint per Section 09905.
e) Fittings: AWWA/ANSI C110/A21.10 ductile.
f) Joints:
(1) AWWA/ANSI C115/A21.15 flanged joints with flanges at valves and structure penetrations.
(2) Provide restrained flange adapters for one joint at each flanged equipment valve and penetration as shown on the drawings.

END OF SECTION

1

2014/08/26

SECTION 15061
PIPE: STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel pipe, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.
   4. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B1.2, Gages and Gaging for Unified Inch Screw Threads.
      c. B16.3, Malleable Iron Threaded Fittings.
      d. B16.5, Pipe Flanges and Flanged Fittings.
      e. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
      f. B16.11, Forged Steel Fittings, Socket Welding and Threaded.
      g. B31.1, Power Piping.
      h. B31.3, Process Piping.
      i. B31.9, Building Services Piping.
      j. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
      d. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      e. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
      f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
      g. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
      h. B6, Standard Specification for Zinc.
      i. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   3. American Water Works Association (AWWA):
      a. C200, Standard for Steel Water Pipe - 6 IN and Larger.
      b. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel water Pipeline - Enamel and Tape - Hot Applied.

c. C205, Standard for Cement-Mortar Lining and Coating for Steel Water Pipe - 4 IN and Larger - Shop Applied.
d. C206, Standard for Field Welding of Steel Water Pipe.
e. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
f. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
g. C209, Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
h. C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
i. C606, Standard for Grooved and Shouldered Joints.
j. M11, Steel Pipe - A Guide for Design and Installation.

4. Society of Automotive Engineers (SAE):
   a. AMS-QQ-P-416, Cadmium Plating Electro deposited.

B. Qualifications:
1. Application of lining and coating materials including preparation of surfaces, priming, and lining and coating of pipe, fittings, and specials, in shop, repairs of any damage to lining or coating occurring during shipment or any other time, and field lining and coating of ends where linings or coatings have been held back for welded field joints, shall be done by established and recognized pipe company acceptable to Engineer.
2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15060.
3. Factory test reports.
4. If mechanical grooved type coupling system is used, submit piping, fittings, and appurtenant items which will be utilized.
5. Coating manufacturer's qualifications.
6. Welders certificates.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Flanged adaptors:
   a. Rockwell (Style 913 (steel)).
   b. Dresser (Style 128 (steel)).
2. Insulating couplings:
   a. Rockwell (Style 416).
   b. Dresser (Style 39).
3. Reducing couplings:
   a. Rockwell (Style 415).
   b. Dresser (Style 62).
4. Transition coupling:
   a. Rockwell (Style 413).
   b. Dresser (Style 62).

5. Compression sleeve coupling:
    a. Rockwell (Style 411 (steel)).
    b. Dresser (Style 38 (steel)).
6. Mechanical couplings and fittings:
    a. Victaulic (Style 07 or 77).
    b. S.P. Fittings.
7. Vibration isolation equipment connections for natural gas:
    a. Flexonics (Model 401H).
8. Flexible connectors for hot water equipment:
    a. Flexonics (FLG Series).
    b. Thermo Tech (F/J/R Series).
9. Factory-applied plastic or epoxy coatings:
    a. "Encoat" Division of Energy Coating Company.
    b. "Scotchkote" Division of 3M Company.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. All materials used in steel piping systems defined in Section 15060 shall meet or exceed pressure test requirements specified for each respective system.

B. Steel Pipe (Fabricated Type):
1. AWWA C200:
    a. ASTM A36, Grade C steel plate.
    b. ASTM A283, Grade D steel plate.
    c. ASTM A572, steel plate.
    d. ASTM A1011, steel sheet.

C. Steel Pipe (Mill Type): ASTM A53, Type E or S.

D. Fittings (For Fabricated Pipe): AWWA C208.

E. Fittings (For Mill Type Pipe):
1. ASTM A234.
2. ASME B16.3, ASME B16.5, ASME B16.9, ASME B16.11.

F. Flanges (Fabricated Pipe):
1. Flange material: ASTM A283, Grade C or D, ASTM A181, Grade 1.
2. Flange finish: Flat faced.

G. Flanges (Mill Type Pipe):
1. ASME B16.5.
2. Flat faced.
3. Slip-on flanges.

H. Nuts and Bolts:
1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application.
2. Exposed: Mechanical galvanized ASTM B695, Class 40.
3. Heads and dimensions per ASME B1.1.
4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 IN beyond nuts.

I. Gaskets: See individual piping systems in Section 15060.

2.3 MANUFACTURED UNITS

A. Couplings:
1. Flanged adaptors:
    a. Steel or carbon steel body sleeve, flange, followers and Grade 30 rubber gaskets.

b. Provide units specified in Article 2.1.
c. Flanges meeting standards of adjoining flanges.
d. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.

2. Compression sleeve coupling:
a. Steel sleeve, followers Grade 30 and rubber gaskets.
b. Provide units specified in Article 2.1.
c. Flanges meeting standards of adjoining flanges.
d. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
e. Provide field coating for buried couplings per AWWA C203.

3. Mechanical coupling joint:
a. Use of mechanical grooved (AWWA C606) type couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 15060.
b. Utilize units defined in Article 2.1.

2.4 ACCESSORIES

A. Heating Water Application:
1. For steel heating lines, provide braided, flanged stainless steel connectors for connection to equipment.
2. Provide pump connectors with stainless steel construction, rubber filled bellows and flanged end connections.

B. Natural Gas Equipment Isolator: 316L stainless steel, T-321 stainless steel braid with connections compatible with joints in piping system.

2.5 FABRICATION

A. Provide piping (mill or fabricated) for use in this Project with minimum wall thicknesses as follows:
1. 1/8 - 5 IN DIA pipe: Schedule 40.
2. 6 - 10 IN DIA pipe: 3/16 IN.
3. 12 - 14 IN DIA pipe: 7/32 IN.
4. 16 - 48 IN DIA pipe: 1/4 IN.
5. 54 - 60 IN DIA pipe: 5/16 IN.
6. 66 - 72 IN DIA pipe: 3/8 IN.
7. Sizes through 24 IN are nominal OD.
a. Sizes greater than 24 are ID.
8. Wall thicknesses indicated are for standard weight pipe.
a. Design pipe in accordance with operating pressures shown in Piping Schedules for a design stress limited to 50 percent of yield.

B. Furnish cast parts with lacquer finish compatible with finish coating.

C. Furnish without outside coating of bituminous material any exposed pipe scheduled to be painted.

D. Fabricated Fittings:
1. AWWA C208.
2. Assure ratio of radius of bend to diameter of pipe equal to or greater than 1.0.

E. Taper cement mortar linings as required for valve interfacing.

F. Protective Coatings and Linings:
1. Provide enamel linings and coatings in accordance with AWWA C203 and the following:
a. Potable water: Provide minimum dry film of 5 mils of asphaltic coating non-toxic blend of Gilsonite and brown and steam distilled asphalt.
b. Nonpotable fluids: Provide minimum dry film of 5 mils of acceptable asphalt base material.

c. Provide coating in accordance with AWWA C203 and subject to following additional requirements.
   1) Do not use enamel lined or coated steel pipe exposed to temperatures below 10 DegF.
   2) Do not handle enamel-lined or coated pipe when temperature of pipe is below 20 DegF.
2. Provide cement mortar lining in accordance with AWWA C205.
3. Provide cement mortar coating in accordance with AWWA C205.
4. Galvanize surface in accordance with hot-dip method using any grade of zinc acceptable to ASTM B6.
5. Wrap pipe in accordance with AWWA C209.
6. Field paint pipe in accordance with Section 09905.

2.6 SOURCE QUALITY CONTROL

A. Testing:
1. Shop hydrostatic test fabricated steel pipe and fittings.
2. Field hydrostatic test all pipe as specified in Section 15060.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Joining Methods - Flanges:
1. Facing method:
   a. Insert slip-on flange on pipe.
   b. Assure maximum tolerances for flange faces from normal with respect to axis of pipe is 0.005 IN per foot of flange diameter.
   c. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.
2. Joining method:
   a. Leave 1/8 to 3/8 IN of flange bolts projecting beyond face of nut after tightening.
   b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
   c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
      1) Allow one (1) flange free movement in any direction while bolts are being tightened.
   d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
   e. Gradually tighten flange bolts uniformly to permit even gasket compression.
   f. Do not overstress bolts to compensate for poor installation.

C. Joining Method - Welded Joints:
1. Perform welding in accordance with AWWA C206 and this Section.
2. For flange attachment perform in accordance with AWWA C207.
3. Have each welding operator affix an assigned symbol to all his welds.
   a. Mark each longitudinal joint at the extent of each operator's welding.
   b. Mark each circumferential joint, nozzle, or other weld into places 180 degrees apart.
4. Welding for all process piping shall conform with ASME B31.3.
   a. Welding of utility piping 125 psi and less shall be welded per ASME B31.9.
   b. Utility piping above 125 psi shall conform to ASME B31.1.
5. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications.

6. Weldolets may be used for 5 IN and larger pipe provided all slag is removed from inside the pipe.
7. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer.
8. Use all long radius welding elbows for expansion loops and bends.
9. Use long radius reducing welding elbows 90 degree bends and size changes are required.

D. Joining Method - Couplings:
1. Compression sleeve:
a. Install coupling to allow space of not less than 1/4 IN but not more than 1 IN.
b. Provide harnessed joint.
1) Use joint harness arrangements detailed in AWWA M11.
c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 15060 and allow for expansion of pipe.
d. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type.
e. Grind smooth welds the length of one (1) coupling on either side of joint to be fitted with any coupling.
f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.
2. Mechanical coupling:
a. Arrange piping so that pipe ends are in full contact.
b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Joining Method - Threaded and Coupled (T/C):
1. Provide T/C end conditions that meet ASME B1.2 requirements.
2. Furnish pipe with factory-made T/C ends.
3. Field cut additional threads full and clean with sharp dies.
4. Leave not more than three (3) pipe threads exposed at each branch connection.
5. Ream ends of pipe after threading and before assembly to remove burrs.
6. Use Teflon thread tape on male thread in mating joints.

F. Support exposed piping in accordance with Section 15060.

G. Install buried piping per Section 15060.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 15060.

END OF SECTION

2014/08/28

SECTION 15062
PIPE: DUCTILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile iron piping, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. ASTM International (ASTM):
      a. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   3. American Water Works Association (AWWA):
      a. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
      b. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C105/A21.5, Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
      c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      e. C150/A21.50, Standard for Thickness Design of Ductile-Iron Pipe.
      f. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   5. Society of Automotive Engineers (SAE):
      a. AMS-QQ-P-416, Cadmium Plating - Electro-deposited.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15060.
   3. Certification of factory hydrostatic testing.
   4. If mechanical coupling system is used, submit piping, fittings, and appurtenant items which will be utilized to meet system requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Restrained flanged coupling adaptors:
      a. Smith-Blair (Series 911 (cast)).
      b. ROMAC (Series FC400)
      c. EBBA (Style 2100)
   2. Compression or split sleeve coupling:
      a. Rockwell (Style 431 (cast)).
      b. Dresser (Style 153 (cast)).
   3. Insulating couplings:
      a. Rockwell (Style 416).
      b. Dresser (Style 39).
   4. Reducing couplings:
      a. Rockwell (Style 415).
      b. Dresser (Style 62).
   5. Transition coupling:
      a. Rockwell (Style 413).
      b. Dresser (Style 62).
   6. Restrained Joints:
      a. EBBA (Style 2100).
   7. Rubber (elastomeric) expansion joint (with limit rods and nuts):
      a. Mercer, Series 450.
         1) Outside nuts to restrict expansion.
         2) Inside nuts (or sleeves) to restrict contraction.
      b. Unaflex, Style 150.
         1) Outside nuts to restrict expansion.
         2) Inside nuts (or sleeves) to restrict contraction.
   8. Restrained compression coupling harness.
      a. Dresser Star Anchor.
      b. Smith-Blair harness assembly.
   9. Polyethylene encasement tape:
      a. Chase (Chasekote 750).
      b. Kendall (Polyken 900).
      c. 3 M (Scotchrap 50).
   10. Restrained joints:
      a. U.S. Pipe (TR-Flex) - 4 IN to 54 IN.
      b. American (Lock Fast) - Above 12 IN.
   11. Accepted Pipe and Fitting Manufacturer:
      a. American Cast Iron Pipe Company.
      b. US Pipe.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Ductile Iron Pipe:
   1. AWWA/ANSI C115/A21.15.
   2. AWWA/ANSI C150/A21.50.
   3. AWWA/ANSI C151/A21.51.

B. Fittings and Flanges:
   1. AWWA/ANSI C110/A21.10.
   2. AWWA/ANSI C115/A21.15.

3. Flanges drilled and faced per ASME B16.1 for both 125 and 250 psi applications.
4. Ductile iron fittings for buried service to be either AWWA/ANSI C110/A21.10 or AWWA/ANSI C153/A21.53 ductile iron compact fittings.

C. Nuts and Bolts:
1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) or 304 Stainless Steel for buried application.
2. Exposed: Mechanical galvanized ASTM B695, Class 40.
3. Heads and dimensions per ASME B1.1.
4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 IN beyond nuts.

D. Gaskets: See individual piping system requirements in Section 15060.

E. If mechanical coupling system is used, utilize pipe thickness and grade in accordance with AWWA C606.

F. Polyethylene Encasement: See AWWA/ANSI C105/A21.5.

G. See Piping Schedules in Section 15060.

2.3 MANUFACTURED UNITS

A. Couplings:
1. Pipe manufacturer is responsible for welding restraint rings required for couplings.
a. Restraint rings to be supplied and designed by coupling manufacturer.
b. Coupling manufacturer to ship restraint rings to the pipe manufacturer.
c. Weld restraint rings per coupling manufacturer requirements.
2. Flanged adaptors:
a. Unit consisting of steel or carbon steel body sleeve, flange, followers, Grade 30 rubber gaskets.
b. Provide units specified in Article 2.1.
c. Supply flanges meeting standards of adjoining flanges.
d. Rate entire assembly for test pressure specified on piping schedule for each respective application.
3. Compression or split sleeve coupling:
a. Unit consisting of steel sleeve, followers, Grade 30 rubber gaskets.
b. Provide units specified in Article 2.1.
c. Supply flanges meeting standards of adjoining flanges.
d. Entire assembly to be rated for test pressure specified on piping schedule for each respective application.
e. Factory applied fusion-bonded epoxy, interior and exterior surfaces.
4. Expansion joint:
a. Provide control rods and compression sleeves.
b. Number and diameter per manufacturer's recommendation for working pressure.
c. Two (2) rod/sleeve assemblies, minimum.
5. Mechanical couplings:
a. Use of mechanical couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 15060.
b. Utilize units defined in Article 2.1.

2.4 FABRICATION

A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.

B. Furnish cast parts with lacquer finish compatible with finish coat.

2.5 SOURCE QUALITY CONTROL

A. Factory Test:
   1. Subject pipe to hydrostatic test of not less than 500 psi with the pipe under the full test pressure for at least 10 seconds.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Joining Method - Push-On Mechanical (Gland-Type) Joints:
   1. Install in accordance with AWWA/ANSI C111/A21.11.
   2. Assemble mechanical joints carefully according to manufacturer's recommendations.
   3. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint.
   4. Do not overstress bolts.
   5. Where piping utilizes mechanical joints with tie rods, align joint holes to permit installation of harness bolts.

B. Joining Method - Push-On Joints:
   1. Install in accordance with AWWA/ANSI C151/A21.51.
   2. Assemble push-on joints in accordance with manufacturer's directions.
   3. Bevel and lubricate spigot end of pipe to facilitate assembly without damage to gasket.
      a. Use lubricant that is non-toxic, does not support the growth of bacteria, has no deteriorating effects on the gasket material, and imparts no taste or odor to water in pipe.
   4. Assure the gasket groove is thoroughly clean.
   5. For cold weather installation, warm gasket prior to placement in bell.
   6. Taper of bevel shall be approximately 30 degrees with centerline of pipe and approximately 1/4 IN back.

C. Joining Method - Flanged Joints:
   1. Install in accordance with AWWA/ANSI C115/A21.15.
   2. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
   3. Make flange faces flat and perpendicular to pipe centerline.
   4. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
   5. Allow one (1) flange free movement in any direction while bolts are being tightened.
   6. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
   7. Gradually tighten flange bolts uniformly to permit even gasket compression.

D. Joining Method - Mechanical Coupling Joint:
   1. Arrange piping so that pipe ends are in full contact.
   2. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
   3. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Flange Adaptors 12 IN and Less:
   1. Locate and drill holes for anchor studs after pipe is in place and bolted tight.
   2. Drill holes not more than 1/8 IN larger than diameter of stud projection.

F. Cutting:
   1. Do not damage interior lining material during cutting.
   2. Use abrasive wheel cutters or saws.
   3. Make square cuts.

4. Bevel and free cut ends of sharp edges after cutting.

G. Support exposed pipe in accordance with Section 15060.

H. Install buried piping in accordance with Section 15060.

I. Install restrained joint systems where specified in Section 15060 under specific piping system.

J. Mechanical Coupling Joints-Jointing Method:
   1. Pipe ends shall be in full contact.
   2. Install pipe and fitting with grooved mechanical couplings in accordance with the manufacturer's recommendation.
   3. Provide technique for installing grooved mechanical coupling systems that will assure connections to pass the pressure testing requirements.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 15060.

END OF SECTION

1

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SECTION 15064
PIPE: PLASTIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic pipe.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. See Specification Section 15060.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. PVC (polyvinyl chloride) materials:
         1) D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
         2) D1785, Standard Specification for Poly(Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
         3) D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
         4) D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
         5) D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
         6) D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
         7) F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
         8) F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
         9) F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
         10) F949, Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
      b. Installation:
         1) D2321, Standard Practice for Underground Installation of Thermosplastic Pipe for Sewers and Other Gravity-Flow Applications.
   2. American Water Works Association (AWWA):
      a. PVC (polyvinyl chloride) materials:
         1) C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN Through 12 IN, for Water Distribution.
         2) C905, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 IN through 48 IN, for Water Transmission and Distribution.
      b. Polyethylene (PE) materials:
         1) C901, Standard for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 IN through 3 IN, for Water Service.
   3. NSF International (NSF).

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 15060.

PART 2 - PRODUCTS

2.1 PVC PRESSURE PIPING (EXPOSED)

A. General:
   1. Provide Schedule 80 pipe with Schedule 80 fittings and appurtenances to locations shown on Drawings.
   2. Furnish materials in full compliance to following material specifications:
      a. Manufacture pipe, fittings and appurtenances from polyvinyl chloride (PVC) compound which meets the requirements of Type 1, Grade 1 (12454-B) Polyvinyl Chloride as outlined in ASTM D1784.
      b. Manufacture pipe, fittings and valves from materials that have been tested and approved for conveying potable water by the NSF.

B. Pipe:
   1. Furnish pipe meeting requirements of ASTM D1785.
   2. Pipe 2 IN and less to be solvent welded.
   3. Pipe larger than 2 IN may be either flanged or solvent welded unless shown otherwise on Drawings.

C. Fittings: Provide ASTM D2467 PVC socket type fittings having the same pressure and temperature rating as the pipe.

D. Flanges/Unions:
   1. Furnish flanges and unions at locations shown on Drawings.
   2. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
   3. For pipe larger than 2 IN, provide 150 LB socket type PVC flange.
   4. For pipe 2 IN and less, provide socket type PVC union with Buna O-rings.
   5. Use flat, full faced natural rubber gaskets at flanged connections.
      a. Furnish heavy hex head bolts, each with one (1) heavy hex nut, ASTM F593 Type 316 stainless steel.
   6. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.

E. Installation:
   1. Field threading PVC will not be permitted.
      a. Perform required threaded connections or attachments by the use of factory molded socket by threaded adapters.
      b. Female adapters are not acceptable.
   2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
      a. Continuously support PVC piping at liquid operating temperatures in excess of 100 DegF.
      b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
      c. Support riser clamps on spring hangers.
      d. Do not clamp PVC tightly or restrict movement for expansion and contraction.

2.2 PRESSURE PIPING (UNDERGROUND)

A. Materials: Furnish materials in full compliance with following requirements:
   1. 1/2-3 IN: AWWA C901 PE with Pressure Class of 200 psi per Table A3, AWWA C901.
   2. 4-12 IN: AWWA C900 PVC with Pressure Class of 200 psi per Table 2, AWWA C900.
   3. Joints for polyethylene pipe shall be fusion type in accordance with AWWA C901.
   4. Joints for PVC pipe shall be the elastomeric-gasket type with a pressure rating not less than pipe pressure rating meeting performance requirements of ASTM D3139.

B. Installation:
   1. Field threading of PVC pipe will not be permitted.
   2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

2.3 PVC DRAINAGE, SEWER PIPING AND UNDERGROUND AIR DUCTS

A. Materials:
   1. Furnish materials in full compliance to the following material specification.
   2. PVC pipe shall be rigid, unplasticized polyvinyl chloride (PVC) made of PVC plastic having a cell classification of 12454-B or 12454-C as described in specification ASTM D1784.
   3. The requirements of this Specification are intended to provide for pipe and fittings suitable for non-pressure drainage of wastewater and surface water.
   4. Joining systems shall consist of an elastomeric gasket joint meeting requirements of ASTM D3212.
   5. Supply to the Engineer all information and sample of joining method for his evaluation.
      a. Only jointing methods acceptable to the Engineer will be permitted.
   6. Provide pipe and fittings meeting or exceeding the following requirements:
      a. 4-27 IN DIA: ASTM D3034 and ASTM F679, SDR 35.
      b. 8-30 IN DIA: ASTM F794.
      c. 4-18 IN DIA: ASTM F949.
   7. Ensure impact strengths and pipe stiffnesses in full compliance to these Specifications.

B. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
   1. Provide for a maximum deflection of not more than 5 percent.

C. Infiltration and Exfiltration:
   1. The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
   2. For exfiltration, all the pipe and fittings shall exceed performance requirements by an air test procedure as specified in Section 15060.
   3. Observe full instructions of the Engineer for carrying of testing procedures.
      a. Perform tests only during presence of the Engineer or his authorized representative.
   4. Should any test on any section of pipe line disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.

D. Deflection:
   1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
   2. Pipe with deflection exceeding 5 percent of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 percent.
   3. Any repaired pipe shall be retested.

2.4 PVC TUBING

A. General: Provide nylon tubing with fittings and appurtenances as shown on Drawings.

B. Materials:
   1. Furnish clear outer braided tubing with braid outside the walls.
   2. Have tubing manufactured of nylon with working temperatures from 5 to 180 DegF.
   3. Design tubing with a minimum safety factor of 4 to 1 ratio of burst pressure to working pressure at maximum temperature.
   4. Provide tubing with working pressure of 75 psi at 180 DegF.
   5. Ensure that tubing is self-extinguishing and fire resistant.

C. Fittings:
   1. Install tubing with nylon fittings and connectors.
   2. Use barbed type adapters with stainless steel clamps.
   3. Provide fittings capable of withstanding temperatures from a -70 to 250 DegF.
   4. Ensure fittings have the same pressure and temperature rating as the tubing.

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Identify each length of pipe clearly at intervals of 5 FT or less.
   1. Include manufacturer's name and trademark.
   2. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

3.2 PRESSURE PIPING (UNDERGROUND)

A. Installation:
   1. Field threading of PVC pipe will not be permitted.
   2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

3.3 PVC DRAINAGE, SEWER PIPING AND UNDERGROUND AIR DUCTS

A. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
   1. Provide for a maximum deflection of not more than 5 percent.

B. Infiltration and Exfiltration:
   1. The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
   2. For exfiltration, all the pipe and fittings shall exceed performance requirements by an air test procedure as specified in Section 15060.
   3. Observe full instructions of the Engineer for carrying of testing procedures.
      a. Perform tests only during presence of the Engineer or his authorized representative.
   4. Should any test on any section of pipe line disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.

C. Deflection:
   1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
   2. Pipe with deflection exceeding 5 percent of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 percent.
   3. Any repaired pipe shall be retested.

3.4 PVC TUBING

A. Fittings:
   1. Install tubing with nylon fittings and connectors.
   2. Use barbed type adapters with stainless steel clamps.
   3. Provide fittings capable of withstanding temperatures from a -70 to 250 DegF.
   4. Ensure fittings have the same pressure and temperature rating as the tubing.

END OF SECTION

1

2014/08/26

SECTION 15090
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.3, Process Piping.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      c. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
      d. Scale drawings showing guides, hangers, supports, anchors, structural members and appurtenances to describe the pipe support system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Hanger Rods:
   1. Material:
      a. ASTM A36.
      b. ASTM A510, Grade 1020.
      c. ASTM A575, Grade M1020.
      d. ASTM A576, Grade 1020.
      e. Minimum allowable tensile stress of 12,000 psi at 650 DegF per MSS SP-58.
   2. Continuously threaded.
   3. Electro-galvanized or cadmium plated after threads are cut.
   4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

B. Hangers:
   1. Hangers for use directly on copper pipe: Copper or cadmium plated.
   2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
   3. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82

C. Concrete Inserts for Hanger Rods:
   1. Continuous slots: Unistrut #P1000.
   2. Individual inserts: ANVIL Figure 281.
   3. Self-drilling expansion anchors: Phillips flush-end or snap-off end type.

D. Beam Clamps for Hanger Rods:
   1. Heavy duty.
   2. ANVIL Figure 134.

E. Trapeze Hangers for Suspended Piping:
   1. Material: Steel.
   2. Galvanized.
   3. Angles, channels, or other structural shapes.
   4. Curved roller surfaces at support point corresponding with type of hanger required.

F. Vertical Pipe Supports:
   1. At base of riser.
   2. Lateral movement:
      a. Clamps or brackets:
         1) ANVIL Figure 103.

G. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

H. Pipe Support Saddle:
   1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
   2. ANVIL Figure 264.

I. Pipe Support Risers:
   1. Schedule 40 pipe.
   2. Galvanized.
   3. As recommended by saddle manufacturer.

J. Pipe Support Base Plate:
   1. 4 IN larger than support.
   2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
   3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
   4. Collar welded to floor plate.
   5. Edges ground smooth.
   6. Assembly hot-dipped galvanized after fabrication.

K. Pipe Covering Protection Saddle:
   1. For insulated pipe at point of support.
   2. ANVIL Figure 167, Type B.

L. Wall Brackets:
   1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
   2. ANVIL Figure 199.

M. Pipe Anchors:
   1. For locations shown on the Drawings.
   2. 1/4 IN steel plate construction.
   3. Hot-dipped galvanized after fabrication.
   4. Designed to prevent movement of pipe at point of attachment.

N. Pipe Guides:
   1. For locations on both sides on each expansion joint or loop.
   2. To ensure proper alignment of expanding or contracting pipe.
   3. ANVIL Figure 256.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58 and MSS SP-69.
   3. Except where modified by this Specification.

E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.1.
   2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

H. Place hangers on outside of pipe insulation.
   1. Use a pipe covering protection saddle for insulated pipe at support point.
   2. Insulated piping 1-1/2 IN and less: Provide a 9 IN length of 9 LB density fiberglass insulation at saddle.
   3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of 9 LB density fiberglass insulation on saddle.

I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

J. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
      c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

   3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

   4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 DegF.

   5. Support each length and every fitting:
      a. Bell and spigot piping:
         1) At least one (1) hanger.
         2) Applied at bell.
      b. Mechanical coupling joints:
         1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
   6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
   7. Provide continuous support for nylon tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.

C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

D. Inspect hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

F. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

G. Welding:
   1. Welding rods: ASTM and AWS standards.
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

H. Field Painting:
   1. Comply with Specification Section 09905.

END OF SECTION

1

2014/08/26

SECTION 15100
VALVES: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Valving, actuators, and valving appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.
   4. Section 11005 - Equipment: Basic Requirements.
   5. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose.
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
      c. D638, Standard Test Method for Tensile Properties of Plastics.
      d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
      e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
      f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
      b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      c. C504, Standard for Rubber-Seated Butterfly Valves.
      d. C507, Standard for Ball Valves, 6 IN through 48 IN (150 MM through 1200 MM).
      e. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      f. C542, Standard for Electric Motor Actuators for Valves and Slide Gates.
      g. C550, Standard for Protective Coatings for Valves and Hydrants.
      h. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.

1.3 DEFINITIONS

A. The following are definitions of abbreviations used in this Specification Section or one (1) of the individual valve sections:
   1. CWP: Cold water working pressure.
   2. SWP: Steam working pressure.
   3. WOG: Water, oil, gas working pressure.
   4. WWP: Water working pressure.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Valve pressure and temperature rating.
      d. Valve material of construction.
      e. Special linings.
      f. Valve dimensions and weight.
      g. Valve flow coefficient.
      h. Wiring and control diagrams for electric or cylinder actuators.
   3. Test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. Verification from valve actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the valve actuator responds correctly to the valve position command.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual valve Specification Sections.

2.3 VALVE ACTUATORS

A. Valve Actuators - General:
   1. Provide actuators as shown on Drawings or specified.
   2. Counter clockwise opening as viewed from the top.
   3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
   4. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.
   5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.

6. Extension stem:
    a. Install where shown or specified.
    b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
    c. Pin all stem connections.
    d. Center in valve box or grating opening band with guide bushing.

B. Buried Valve Actuators:
1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum diameter, 3/16 IN minimum thickness, and identifying cast iron cover rated for traffic load.
2. Box base to enclose buried valve gear box or bonnet.
3. Provide 2 IN standard actuator nuts complying with AWWA C500, Section 3.16.
4. Provide at least two (2) tee handle keys for actuator nuts, with 5 FT extension between key and handle.
5. Extension stem:
    a. Provide for buried valves greater than 4 FT below finish grade.
    b. Extend to within 6 IN of finish grade.
6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.

C. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric or cylinder actuators.
2. Provide handwheels for gate and globe valves.
    a. Size handwheels for valves in accordance with AWWA C500.
3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN DIA and smaller.
    a. Lever actuators for butterfly valves shall have a minimum of 5 intermediate lock positions between full open and full close.
    b. Provide at least two (2) levers for each type and size of valve furnished.
4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 IN DIA and larger.
5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
    a. Cadmium-plated chain looped to within 3 FT of finish floor.
    b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
8. Provide cast iron floor stands where shown on Drawings.
    a. Stands to be furnished by valve manufacturer with actuator.
    b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

D. Submerged Actuators:
1. Mount the valve actuator on top of an extension bonnet 3 FT above any adjacent personnel access.
2. The valve and bonnet connection shall be flanged and watertight.
3. Provide a top brace support and intermediate support(s).
    a. Install intermediate supports per manufacturer’s recommendations.
4. Materials:
    a. Brace supports and anchor bolts: Type 304 stainless steel.

2.4 FABRICATION

A. End Connections:
1. Provide the type of end connections for valves as required in the Piping Schedules presented in Specification Section 15060 or as shown on the Drawings.
2. Comply with the following standards:
    a. Threaded: ASME B1.20.1.

b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
d. Soldered: ASME B16.18.
e. Grooved: Rigid joints per Table 5 of AWWA C606.

B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

C. Nuts, Bolts, and Washers:
1. Wetted or internal to be bronze or stainless steel.
a. Exposed to be zinc or cadmium plated.

D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.

E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with Specification Section 09905 for painting and protective coatings.

C. Setting Buried Valves:
1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
2. Set valves and valve boxes plumb.
3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
4. Install in closed position.
5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.

D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

E. For grooved coupling valves, install rigid type couplings.

F. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

G. For threaded valves, provide union on one (1) side within 2 FT of valve to allow valve removal.

H. Install valves accessible for operation, inspection, and maintenance.

3.2 ADJUSTMENT

A. Adjust valves, actuators and appurtenant equipment to comply with Specification Section 01650.
1. Operate valve, open and close at system pressures.

3.3 SCHEDULES

A. Valves less than 4 IN may not be scheduled but type and size are defined on Drawings in plan, section, isometric or schematic.

B. Mechanical valves are not scheduled but type and size are defined on Drawings in plan, section, isometric or schematic.

C. Column "Remote or Integral Operation" refers to operator's position when valve is operated (i.e., handwheel/lever, chainwheel, pushbutton, etc.).

D. See Section 15060 and the Drawings for Piping Service designations.

E. Unless shown otherwise on Drawings and Drawing schedules, provide valves as shown in schedule attached at the end of this Section.

F. The attached schedule is provided to assist the Contractor in identifying manual valves 4 IN and greater in size and control valves.
   1. Manual valves below 4 IN in size are defined at other locations in the Contract Documents.
   2. The Contractor shall not use this schedule as a bill of materials but shall review the Contract Documents in their entirety to establish the number, sizes and types of valves on the project.
   3. Valves not listed generally include small valves and certain valves furnished as components in items of equipment.
   4. The Contractor is responsible for furnishing all valves to provide a complete, ready-to-operate facility.

END OF SECTION

1

City of Yankton, SD - Water System Improvements, Horizontal Collector Well - Process Valve Schedule

Valve	Location	Size	Type	Actuator	Exposed/ Buried	Joints
PCV01	Collector Well Pump No. 1 Pump Control Valve	16	Diaphragm	Solenoid/Automatic	Exposed	Flanged
PCV02	Collector Well Pump No. 2 Pump Control Valve	16	Diaphragm	Solenoid/Automatic	Exposed	Flanged
PCV03	Collector Well Pump No. 3 Pump Control Valve	16	Diaphragm	Solenoid/Automatic	Exposed	Flanged
BFV01	Collector Well Pump No. 1 Isolation Valve	16	AWWA Butterfly	Manual	Exposed	Flanged
BFV02	Collector Well Pump No. 2 Isolation Valve	16	AWWA Butterfly	Manual	Exposed	Flanged
BFV03	Collector Well Pump No. 3 Isolation Valve	16	AWWA Butterfly	Manual	Exposed	Flanged
BFV04	Future Collector Well Pump No. 4 Isolation Valve	16	AWWA Butterfly	Manual	Exposed	Flanged
CWGV01	Collector Well Gate Valve No. 1	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV02	Collector Well Gate Valve No. 2	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV03	Collector Well Gate Valve No. 3	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV04	Collector Well Gate Valve No. 4	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV05	Collector Well Gate Valve No. 5	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV06	Collector Well Gate Valve No. 6	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV07	Collector Well Gate Valve No. 7	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV08	Collector Well Gate Valve No. 8	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV09	Collector Well Gate Valve No. 9	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV010	Collector Well Gate Valve No. 10	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV011	Collector Well Gate Valve No. 11	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV012	Collector Well Gate Valve No. 12	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
CWGV013	Collector Well Gate Valve No. 13	12	RW Gate Valve	Manual W/Extension Stem	Exposed	Flanged
AVV01	Collector Well Pump No. 1 Air/Vacuum Valve	3	Air/Vacuum Valve	Automatic	Exposed	Flanged
AVV02	Collector Well Pump No. 2 Air/Vacuum Valve	3	Air/Vacuum Valve	Automatic	Exposed	Flanged
AVV03	Collector Well Pump No. 3 Air/Vacuum Valve	3	Air/Vacuum Valve	Automatic	Exposed	Flanged
AVV05	Main Discharge Header Air/Vacuum Valve	6	Air/Vacuum Valve	Automatic	Exposed	Flanged

2014/08/28

SECTION 15101
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gate valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15100 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. American Water Works Association (AWWA):
      a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      b. C504, Standard for Rubber-Seated Butterfly Valves.
      c. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      d. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
      b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
      c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

A. OS&Y: Outside Screw and Yoke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 VALVES: WATER; 2-1/2 IN AND SMALLER

A. Class 125 bronze gate valve.

B. Comply with MSS SP-80.

C. Materials:
   1. Body, bonnet, wedge: Bronze.
   2. Stem: Silicon bronze.
   3. Packing: Aramid fibers with graphite (Kevlar®).

D. Design Requirements:
   1. 125 psi steam, 200 psi nonshock WOG.
   2. Screw in bonnet, non-rising stem, solid wedge.

E. Acceptable Manufacturers:
   1. Nibco.
   2. Stockham.

2.3 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, AND NON-POTABLE)

A. Double Disc Gate Valve, 3 to 12 IN (Water Application):
   1. Comply with AWWA C500.
   2. Materials:
      a. Seating surfaces, stems, stem nut: Bronze.
      b. Body, disc: Cast iron.
   3. Design requirements:
      a. 200 psi working pressure.
      b. Buried: NRS, O-ring stem seal, 2 IN operation nut.
      c. Exposed: NRS, O-ring stem seal, handwheel.
   4. Acceptable manufacturers:
      a. American Flow Control.
      b. Clow.
      c. M&H.
      d. Mueller.

B. Resilient Wedge Gate Valves, 2 to 48 IN (Water, Wastewater Application):
   1. Comply with AWWA C509.
   2. Materials:
      a. Stem and stem nut: Bronze.
         1) Wetted bronze parts in low zinc bronze.
         2) Aluminum bronze components: Heat treated per AWWA C504.
      b. Body, gate: Cast iron.
      c. Resilient wedge: Styrene Butadiene Rubber (SBR).
   3. Design requirements:
      a. Minimum 200 psi working pressure.
      b. Buried: NRS, O-ring stem seal, 2 IN square operating nut.
      c. Exposed: OS&Y, stuffing box stem seal, handwheel.
      d. Submerged: RS, stuffing box stem seal.
      e. Counter clockwise open rotation.

f. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
   1) Comply with AWWA C550.
   2) Wetted bronze parts in low zinc bronze.
   3) Aluminum bronze components: Heat treated per AWWA C504.

4. Acceptable manufacturers:
   a. Clow.
   b. Mueller.
   c. American Flow Control.
   d. M & H.

2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
   1. Furnish actuator integral with valve.
   2. Gate valves on the collector well laterals are to be provided with extensions stems with 2" actuator nuts, guides, and bracing as shown on the drawings.

B. Refer to Specification Section 15100 for actuator requirements.

2.5 FABRICATION

A. General:
   1. Provide valves with clear waterways the full diameter of the valve.

B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.

C. Do not install gate valves inverted or with the stems sloped more than 45 degrees from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

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2014/08/14

SECTION 15103
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Butterfly valves.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.
   4. Section 15100 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      e. A436, Standard Specification for Austenitic Gray Iron Castings.
      f. A536, Standard Specification for Ductile Iron Castings.
      g. B148, Standard Specification for Aluminum-Bronze Sand Castings.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-67, Butterfly Valves.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.
   3. For valves 8 IN and larger, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. DeZurik.
   2. Clow.
   3. Mueller.
   4. Pratt.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 BUTTERFLY VALVES (AWWA C504)

A. Comply with AWWA C504.

B. Materials:
   1. Valve bodies:
      a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
      b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
   2. Valve shafts:
      a. Stainless steel, 18-8, Type 304 or 316.
   3. Valve discs:
      a. Potable and nonpotable water:
         1) ASTM A48, Class 40 cast iron.
         2) ASTM A536, Grade 65-45-12 ductile iron.
         3) ASTM A436, Type 1 alloy cast iron.
         4) Bronze in accordance with AWWA C504.
      b. Air and similar applications: ASTM A48, Class 40 cast iron.
   4. Valve seats:
      a. Potable and nonpotable water below 150 DegF:
         1) Natural rubber.
      b. Potable and nonpotable water and air below 180 DegF:
         1) Buna-N.
      c. Heating water and air 180 to 250 DegF.
         1) EPDM.
   5. Mating surfaces:
      a. Valves less than 30 IN: ASTM A276, 18-8, stainless steel or bronze.
      b. Valves 30 IN and larger: ASTM A276, 18-8, stainless steel.

C. Design Requirements:
   1. Seat type:
      a. Resilient.
      b. Comply with AWWA C504.
   2. Exposed and submerged valves 3 through 20 IN.
      a. Body type: Wafer or short body flange (laying length may vary from AWWA C504).
      b. Equip wafer type with fully tapped anchor lugs drilled per ASME B16.5.
   3. Exposed and submerged valves 24 IN and larger:
      a. Body type: Short body flange.
      b. Working pressure: Rated for 150 psi (Class 150B per AWWA C504).
   4. Direct buried valves:
      a. All valves: Working pressure rated for 150 psi (Class 150B per AWWA C504).

2.3 ACCESSORIES

A. Refer to Drawings and/or valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Section 15100 for actuator requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 15100.

END OF SECTIO

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2014/08/26

SECTION 15104
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15100 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   2. American Water Works Association (AWWA):
      a. C507, Standard for Ball Valves, 6 IN through 48 IN.
   3. Federal Specification (FS):
      a. WW-V-35C, Valve, Ball.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.
   3. Test results for AWWA valves.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 METALLIC BALL VALVES 1/4 TO 3 IN DIA

A. Comply with FS WW-V-35C Type II, Class A.

B. Acceptable Manufacturers:
   1. Apollo.
   2. Jamesbury.
   3. Watts.
   4. Stockham.
   5. Nibco.

C. Materials:
   1. Body: Bronze.
   2. Stem, stem gland nut: Brass.
   3. Ball: Brass, chrome plated.
   4. Seats, stuffing box ring, and thrust washer: Reinforced Teflon.
   5. Handle: Vinyl coated or zinc- or cadmium-plated steel.

D. Design Requirements:
   1. Rated for 400 psi and 250 DegF, WOG for threaded end applications and 285 psi WOG and 150 psi saturated steam service for flanged end applications.
   2. Handles showing direction of opening.
   3. Stuffing boxes capable of being repacked under pressure and adjustable for wear.
   4. Stem with reinforced Teflon stuffing box ring and blowout-proof design.
   5. Renewable reinforced Teflon seats.
   6. Ball design which does not allow media contact with stem.
   7. Balancing stop for all applications.
   8. Bodies with mounting pad for applications requiring actuators.

2.3 PLASTIC BALL VALVES: 1/2 IN TO 4 IN DIA

A. Acceptable Manufacturers:
   1. Chemtrol.
   2. Spears.
   3. ASAHI/America.

B. Materials:
   1. Body, stem, ball, handle, end connectors:
      a. PVC ASTM D1784-12454B or CPVC ASTM D1784-23447-B to match piping.
   2. Ball Seat: Teflon.
   3. O-rings: Viton.

C. Design Requirements:
   1. Rated at 150 psi at 75 DegF.
   2. Full round ball.
   3. Double or "true union" design.
   4. Blocks both directions, upstream and downstream.
   5. Union nut capable of compensating for seat wear.
   6. Body with mounting pad for actuators where required.
   7. Capable of being disconnected at downstream end under full line pressure.

2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 15100 for actuator requirements.

2.5 SOURCE QUALITY CONTROL

A. Shop test AWWA C507 ball valves in accordance with AWWA C507.

B. Furnish record of test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

3.2 FIELD QUALITY CONTROL

A. For AWWA C507 ball valves, and in accordance with Specification Section 01650 employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.

END OF SECTION

1

2014/08/26

SECTION 15106
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Check valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15100 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 IN through 24 IN NPS.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
      b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, manufacturers listed under the valve with types are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 CHECK VALVES: 2.5 IN AND SMALLER

A. Class 125 Bronze Swing Check Valves (Water):
   1. Comply with MSS SP-80.

2. Acceptable manufacturers:
    a. Nibco T413-Y.
    b. Stockham B-319Y.
3. Materials:
    a. Body, bonnet, disc: Bronze.
4. Design requirements:
    a. 125 psi steam to 406 DegF, 200 psi WOG.
    b. Horizontal swing, renewable disc.

2.3 SWING CHECK VALVES: 3 IN TO 24 IN

A. Swing Check Valves (Water):
1. Comply with AWWA C508.
2. Acceptable manufacturers:
    a. Clow.
    b. American Darling.
    c. Golden Anderson.
3. Materials:
    a. Body and cover: Cast iron.
    b. Seat ring, hinge: Bronze.
    c. Disc:
        1) 3 to 4 IN: Bronze.
        2) 6 to 24 IN: Cast iron with bronze face.
        3) 6 to 24 IN: Cast iron with rubber face.
    d. Hinge shaft: Stainless steel.
    e. Bearings, connecting hardware: Bronze.
4. Design requirements:
    a. 175 psi working pressure (3 to 12 IN).
    b. 150 psi working pressure (14 to 24 IN).
    c. Furnish with outside weight and lever or lever and spring.

2.4 BALL CHECK VALVES: 1/2 IN TO 4 IN

A. Smaller than 4 IN:
1. 150 psi at 73 DegF.
2. Acceptable manufacturers:
    a. R&G Sloane.
    b. Corr Tech.
    c. Or approved equal.
3. Materials:
    a. Body: PVDF.
    b. Ball: PVDF.
    c. Seals: Teflon.
4. Design requirements:
    a. Connectors: Double union.

B. 4 IN through 14 IN:
1. 145 psi at 176 DegF.
2. Acceptable manufacturers:
    a. Flygt.
    b. Ball Check.com, Division of Process Equipment.
    c. Or approved equal.
3. Materials:
    a. Body and cover: Nodular cast iron.
    b. Joints:
        1) ASME B16.1, Class 125 flat face.
        2) Bolt holds shall straddle valve centerline.

c. Ball: Metal core with vulcanized nitrile rubber covering.
4. Style: Manufacturer to select correct ball type and weight for intended fluid.
5. Fluid: Thickened lime sludge (20 percent solids maximum) from gravity thickeners and, lime residual (5 percent solids maximum) from contact basins.
6. Installation: Able to be installed in either the vertical or horizontal position.

2.5 AUTOMATIC CONTROL VALVES (PUMP CONTROL VALVES, PCV01, PCV02, AND PCV03)

A. Basic Valve:
1. Type:
a. Diaphragm-actuated hydraulically operated.
1) Acceptable manufacturers (Model as shown for specific valve):
a) Cla-Val Model 660-31.
b) Singer.
2) Pattern: Globe with flange end connections, 150 Class.
3) Materials:
a) Body: Ductile iron.
b) Disc retainer & diaphragm washer: Cast iron.
c) Seat insert: Stainless steel.
d) Stem, nut, and spring: Stainless Steel.
e) Disc: Buna-N.
f) Diaphragm: Nylon fabric bonded with synthetic rubber.
4) Design requirements: Do not use diaphragm as seating surface.
2. Design requirements:
a. Simple Hydraulic Operation.
b. Low Head Loss.
c. Built-in Check Valve
d. Size: 16 IN, reduced port.
e. Operating pressure:
1) Maximum 90 psi.
2) Minimum 55 psi.
f. Flow range:
1) Normal maximum 5,600 gpm.
2) Normal minimum 2,000 gpm.

B. Control:
1. Design requirements:
a. Control opening and closing speed of basic valve to minimize surge associated with starting and stopping of a pump. See Section 13441 for control loop description.
b. Design normal opening and closing to be concurrent with pump operation.
c. Provide for a more rapid valve closure in event of power outage.
d. Provide adjustable controlled rates for all opening and closing speeds.

C. Design Requirements:
1. Assembles all control features and hardware on basic valve at factory.
2. Use corrosion-resistant metal for all exposed portions of the control.
3. Include with valve control:
a. Stop valves.
b. Strainer.
c. Valves for opening and closing speed control.
d. Pilot valves.
e. Solenoid valves.
1) Body: Brass ASTM B283.
2) Enclosure: Weatherproof, watertight 4X.
3) Voltage: 120 volts.
4) Insulation: Class F.

f. Limit switches: 120 volt.
g. Pressure switches as necessary to provide control function.

4. Electric components:
   a. 120 V, 1 PH.
   b. In weatherproof enclosure unless shown otherwise on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

B. Install in accordance with manufacturer's instructions.

END OF SECTION

2014/08/28

SECTION 15114
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air release and vacuum relief valves.
   2. Pressure-reducing valves (2 IN and smaller).
   3. Pressure relief valves (1 IN and smaller).
   4. Solenoid valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 15100 - Valves: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
      b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.
   3. Canadian Standards Association (CSA).
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 AIR RELEASE AND VACUUM RELIEF VALVES

A. General: Conform to AWWA C512.

B. Air Release Valve:
1. Acceptable manufacturers:
a. APCO 200A.
b. GA Industries, Figure 920.
2. Materials:
a. Body and cover: Cast iron or semi-steel.
b. Float: Stainless steel.
c. Linkage and trim: Bronze or stainless steel.
3. Design requirements:
a. Specifier: Verify size for the project.
b. Size: 1 IN.
c. Working pressure: Refer to applicable systems.
d. Release 10 cfm at 10 psi differential at 150 psi line pressure.

C. Air/ Vacuum Valve (AVV01, AVV02, AVV03, and ARV-04):
1. Acceptable manufacturers:
a. APCO Series 140/150.
b. GA Industries, Figure 945 or 960.
c. ARI.
2. Materials:
a. Body and cover: Cast iron or Ductile Iron.
b. Float, linkage and hardware: Stainless steel.
c. Seat: Buna-N.
3. Design requirements:
a. Size: As shown on the Drawings. Manufacturer to confirm size.
1) Collector Well Pump 16 IN Discharge (AVV01, AVV02, and AVV03):
a) Flow: 2,000 to 5,600 gpm.
b) Working pressure: 55 to 95 psi.
2) High Service Pump 30 IN Discharge Header (AVV05):
a) Flow: 2,000 to 16,700 gpm.
b) Working pressure: 55 to 95 psi.
b. Release 10 cfm at 10 psi differential at 150 psi line pressure.
c. Air vacuum capacity: Refer to Process Valve Schedule.
d. Provide isolation valve, type as shown on the Drawings.

2.3 PRESSURE RELIEF VALVE (1 IN AND SMALLER)

A. Acceptable Manufacturer:
1. Fisher 98 Series.

B. Materials:
1. Body: Stainless steel.
2. Spring: Steel.
3. Diaphragm water - neoprene.
4. Trim: 416 stainless steel.

C. Design Requirements:
1. Pipe relief to discharge at non-hazardous location.

2.4 SOLENOID VALVES (1 IN AND SMALLER)

A. General Service (Air - Water):
1. Acceptable manufacturer:
a. ASCO.
2. Materials:
a. Body: Brass.
b. Seat: Buna-N.
c. Insulation: Class F.

3. Design requirements:
    a. 110 Vac.
    b. Two-way, normally closed.
    c. Enclosure: Compatible with area classifications indicated on Drawings.
    d. Working pressure, air and water: 125 psig.
4. Accessories: Provide strainer on supply.

2.5 ACCESSORIES

A. Furnish any accessories required to provide a completely operable valve.

2.6 FABRICATION

A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.

B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.7 SOURCE QUALITY CONTROL

A. Shop hydrostatically test to piping system test pressure.

2.8 MAINTENANCE MATERIALS

A. Provide one (1) set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: See Specification Section 11005 and Specification Section 15100.

B. Air Release, Vacuum Relief, and Pressure Relief Valves:
    1. Pipe exhaust to a suitable disposal point.
    2. Where exhausted to a trapped floor drain, terminate exhaust line 6 IN minimum above floor.

C. Float-Operated Valves: Install baffle around float to minimize turbulence adjacent to float.

3.2 FIELD QUALITY CONTROL

A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.

B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

1

2014/08/28

SECTION 15183
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Insulation:
      a. Piping insulation.
      b. Duct insulation.
      c. Equipment insulation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15890 – HVAC: Ductwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
      b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
      c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      e. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      f. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
      g. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      h. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      i. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      j. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      k. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
   2. National Fire Protection Association (NFPA):
      a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   3. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.
c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.

3. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
4. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Elastomeric insulation:
      a. Rubatex.
      b. Armstrong.
   2. Fiberglass insulation:
      a. Certainteed Corporation.
      b. Schuller (Manville).
      c. Owens Corning.
      d. Knauf.
   3. PVC jacket:
      a. Ceel-Co.
      b. PIC Plastics.
   4. Equipment insulation:
      a. Certainteed Corporation.
      b. Schuller (Manville).
      c. Owens Corning.
   5. Ductwork insulation:
      a. Certainteed.
      b. Schuller (Manville).
      c. Owens Corning.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PIPING INSULATION - ELASTOMERIC

A. General:
   1. Insulation fire and smoke hazard ratings for composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation), as tested by procedure ASTM E84, NFPA 255 and UL 723, not exceeding:
      a. Flame spread: 25.
      b. Smoke developed: 50.
   2. Accessories (adhesives, mastics, cements, and tapes: Same component ratings as listed above.
   3. Indicate on product labels or their shipping cartons: Flame and smoke ratings do not exceed above requirements.
   4. Permanent treatment of jackets or facings to impart flame and smoke safety is required.
      a. Water-soluble treatments are prohibited.
   5. Insulated shields at pipe support points.

B. Pipe, Fitting, and Valve Insulation:
   1. Flexible elastomeric closed cell pipe insulation.
      a. Average thermal conductivity not to exceed 0.27 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DegF, temperature range -40 to 220 DegF; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistance.
   2. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:
   1. Preformed fiberglass pipe insulation:
      a. Density: 4 LBS/CF.
      b. Temperature rated: 650 DegF.
      c. Average thermal conductivity not to exceed 0.22 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DegF.
      d. Fire hazard rating:
         1) UL 723, ASTM E84, NFPA 255.
         2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.
   3. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.
      c. Flame attenuated glass fibers bonded with thermosetting resin.
   4. Piping jackets (general applications):
      a. Aluminum: 16 mil embossed aluminum.
      b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
      c. Piping jacket not required on concealed piping.
   5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.4 EQUIPMENT INSULATION

A. Insulation for Equipment:
   1. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Provide minimum insulation thickness conforming to Schedules, or as shown on Drawings.

2.5 DUCTWORK INSULATION: FIBERGLASS

A. Flexible Insulation:
   1. Scheduled thickness: Schuller (Manville) Microlite.
   2. Factory-applied foil scrim vapor barrier facing.
   3. Average thermal conductivity not to exceed 0.27 (Btu-IN)/(HR-FT^2-DegF) at a mean temperature of 75 DegF (installed).
   4. Minimum density: 0.75 LB/CF.
   5. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.

B. Semi-Rigid Insulation for Indoor Installation:
   1. Scheduled thickness Schuller (Manville) #814 SPIN-GLASS fiberglass duct insulation.
   2. Factory applied vapor barrier facing-white scrim foil.
   3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at a mean temperature of 75 DegF.
   4. Minimum density: 3.0 LB/CF.
   5. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.

C. Semi-Rigid Insulation for Outdoor Installation:
   1. Outside ducts: Surface with scheduled thickness of Schuller (Manville) 800 Series SPIN-GLASS #815 fiberglass duct insulation.
   2. Factory-applied foil scrim vapor barrier facing.
   3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DegF.
   4. Minimum density: 3 LBS/CF.
   5. Finish with Benjamin Foster #4610 weatherproof mastic with white glass fabric membrane.
   6. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.

D. Provide minimum insulation thickness conforming to Schedule, or as shown on Drawings.

E. Duct Interior Lining Board:
   1. Acoustical performance: Minimum noise reduction coefficients (NRC) is 0.45 when tested in accordance with ASTM C423 on ASTM F25 mounting.
   2. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   3. Service temperature:
      a. ASTM C411.
      b. Cooling and heating ducts up to 200 DegF.
   4. Velocity rating:
      a. ASTM C1071.
      b. Maximum average air velocity is rated at 600 fpm.
   5. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.
   6. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.
   7. Size and performance:
      a. ASTM C518 and ASTM C177.
      b. 1 IN thickness, long textiled glass-type fibers firmly bonded by thermosetting resin.
      c. At 75 DegF mean temperature, the k value, expressed as (Btu-IN)/(HR-FT^2-DegF) does not exceed 0.27.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
2. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
a. Consider ductwork, piping and equipment above ceilings as concealed.
3. Provide release for insulation application after installation and testing is complete.
a. Apply insulation on clean, dry surfaces after inspection.
4. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
5. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
6. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Piping Insulation - Elastomeric:
1. Slip insulation on pipe prior to connection.
a. Whenever the slip-on technique is not possible provide insulation neatly slit and snapped over the pipe.
2. Fabricate and install fitting cover insulation according to manufacturer's recommendations.
3. Seal joints, slits, miter-cuts and other exposed edges of insulation with adhesive, recommended by the insulation manufacturer, to ensure complete vapor barrier.

D. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
a. Butt all joints together firmly.
2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
4. PVC pipe jacket:
a. Apply jacketing with a minimum of 1 IN overlap.
1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
c. Provide premolded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
5. Aluminum pipe jacket:
a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
b. Provide smooth and straight joint with a minimum 2 IN overlap.
c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
d. Center spacing of screws 5 IN maximum or as required to provide smooth tight-fitted joints.
e. Place joints on least exposed side of piping to obtain neat appearance.

E. Equipment: Install per manufacturer's instructions.

F. Ductwork Insulation - Fiberglass:
1. Flexible insulation:
a. Butt edges tightly.
1) Secure insulation with Benjamin Foster 85-20 adhesive applied in 6 IN strips on 12 IN centers and/or pins, applied on not more than 18 IN centers so that the insulation conforms to the duct surfaces uniformly and firmly.
b. Seal joints with facing overlap or 4 IN wide strips of like facing material adhered and stapled in place.

c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20.
d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.

2. Semi-rigid insulation and duct interior lining board:
   a. Impaling over pins.
      1) Apply insulation with edges tightly butted.
      2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
      3) Clip pins off close to clip.
      4) Space pins as required to hold insulation firmly against duct surface but not less than one (1) pin per 1.5 SF.
      5) Seal joints and speed clips with 3 IN wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
   b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
      1) Cover the entire surface of duct with adhesive.
      2) Use corner metal angle to protect edge of insulation.
      3) Protect edge of insulation.
      4) Seal joints as above.

G. Install interior duct lining board as indicated above.
   1. Overall length shall be as indicated on the Drawings or a minimum of 10 LF past any type of air supply fan.

3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

A. Refrigeration Lines (35-60 DegF):
   1. Elastomeric.
   2. 1/2 IN thickness for lines 1 IN and smaller.

B. Pipe, Fittings and Valves:
   1. Fiberglass.

APPLICATION	PIPE SIZE	THICKNESS	JACKET
Roof Drainage	2-1/2 to 6 IN	1/2 IN	PVC
Hot Water (domestic)	6 IN and less	3/4 IN	PVC
Cold Water (domestic)	3 IN and less	3/4 IN	PVC
	Over 3 IN	1 IN	
Heating Water (120 - 230 DegF)	6 IN and less	1 IN	PVC
Refrigeration Lines (35 - 60 DegF)	Over 1 IN	1 IN	PVC
Chilled Water (35 - 60 DegF)	4 IN and less	1 IN	PVC
	Over 4 IN	1-1/2 IN	

C. Equipment:

EQUIPMENT	INSULATION SYSTEM
Hot water and steam, heating equipment, heat exchangers, air separators, strainers, condensate, receivers	2 IN fiberglass insulation. Glass mesh jacket adhered and coated with two (2) coats of Foster 30-36 white insulation coatings.
Hot water pumps, flash tanks, compression tanks	Uninsulated
Below drain pans serving cooling coils, pre-heat systems, domestic water heaters	1 IN flexible elastomeric closed cell sheet.

D. Ductwork:

1. Metallic:

DUCT SERVICE	INSULATION AND THICKNESS
Supply air ducts downstream of cooling coils	1 IN flexible with vapor barrier
All other ductwork	Uninsulated

END OF SECTION

1

2014/07/31

SECTION 15510
FIRE HYDRANT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Dry-barrel fire hydrant.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.
   4. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. C502, Standard for Dry-Barrel Fire Hydrants.
      b. M17, Installation, Operation and Maintenance of Fire Hydrants.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Acknowledgement that products submitted meet the requirements of the standards referenced.
      b. Manufacturer's installation instructions.
      c. Acknowledge and verify dimensions and provide list of integral parts and materials.
   3. Prior to submission of Shop Drawings, submit one (1) copy of complete submittal information direct to local fire department, Attn: Fire Chief, and request and secure written approval of hydrant selection.
      a. Incorporate copies of written approval letter with submittals.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Mueller,
   2. American Flow Control,
   3. Waterous.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 FIRE HYDRANT

A. Design and Fabrication:
   1. Conform to AWWA C502.

2. Provide with either compression or gate design.
3. Provide with a 5-1/4 IN valve opening, nozzle section consisting of two (2) 2-1/2 IN hose nozzles and one (1) 4-1/2 IN steamer.
4. Provide with water passages to permit full flow of water to minimize friction loss.
5. Furnish with multiple weep holes for positive draining to allow water to escape readily from standpipe when hydrant valve is closed.
6. Designed to throttle flow when partially opened.
7. Designed to allow removal of valve and valve stem without digging up hydrant.
8. Suitable for 7.5 FT of bury.
9. Furnish with mechanical (gland type) joint inlet connections.
10. Design to break off at ground line when struck by a vehicle.
11. Furnish with O-ring packing only.
12. Furnish hose and steamer nozzles with threads conforming to standard threads used by local Fire Department.
13. Furnish with direction of opening as required by local Fire Department with direction of opening cast on dome.
14. Color: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hydrants at locations indicated in accordance with AWWA M17 and the following:
   1. Remove foreign material from barrel of hydrant before placement.
   2. Install plumb and at same elevation as connecting pipe and main.
   3. Place each hydrant on a slab of concrete not less than 6 IN thick and 18 IN SQ.
   4. Block backside of hydrant, opposite pipe connection, with concrete firmly wedged between hydrant and vertical face of undisturbed trench.
   5. Place granular bedding material around base of hydrant to the dimensions shown in the Drawings.
   6. Firmly tamp carefully compacted backfill around hydrant to surface of ground and to a distance of 5 FT in front of hydrant.

3.2 COATINGS AND FINISHES

A. Provide hydrant with below grade and above grade coatings as per Section 09905.
   1. Paint above grade with color conforming to the requirements of the local Fire Department.

END OF SECTION

2014/08/14

SECTION 15515
HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Hydronic specialties.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 15970 - Instrumentation and Control for HVAC Systems.
   5. Section 15990 - HVAC Systems: Balancing and Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
   3. ASTM International (ASTM):
      a. A159, Standard Specification for Automotive Gray Iron Coating.
      b. B36, Standard Specification for Brass Plate, Sheet, Strip and Rolled Bar.
      c. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
      d. B85, Standard Specification for Aluminum-Alloy Die Castings.
      e. B99, Standard Specification for Copper-Silicon Alloy Wire for General Purposes.
      f. B371, Standard Specification for Copper-Zinc-Silicon Alloy Rod.
      g. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   4. Expansion Joint Manufacturer's Association (EJMA).
   5. National Electrical Manufacturers Association (NEMA).
   6. Society of Automotive Engineers (SAE).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's catalog cuts and technical information.
      d. Pump curves.
   4. Certifications.
   5. Test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Combination strainer and air separator:
      a. Bell and Gossett; Rollairtrol.
   2. Balancing valves and readout meters:
      a. Bell and Gossett; Circuit Setter Balance valves and Model R0-2 meter.
   3. Flow measuring devices and meters:
      a. Aeroquip.
      b. Barco.
      c. Dieterich Standard Corp.
   4. Heating water pumps:
      a. Bell and Gossett.
   5. Expansion joints:
      a. Flexonics Div.
      b. Zallea Brothers, Inc.
      c. Pathway Bellows, Inc.
   6. Flexible connections:
      a. Flexonics Div.
      b. Barco.
      c. Anaconda Metal Hose.

B. Submit request for substitution in accordance with Specification Section 01640.

1.5 EQUIPMENT

A. Manual Air Relief Vents:
   1. Type: Class 150 bronze gate with rising stem and solid wedge.
   2. Material:
      a. Bonnet, body and wedge: Bronze ASTM B62.
      b. Packing nut and packing gland: Bronze ASTM B62 or ASTM B584 alloy C84400.
      c. Stem: Silicon Bronze ASTM B371 Alloy C69400 or ASTM B99 alloy C65100 H04.
      d. Hand wheel: Aluminum ASTM B85 Alloy A03800.
      e. Hand wheel nut: Zinc-plated steel with clear chromate.
   3. Design limitations: 150 psi steam at 406 DegF minimum.
   4. Relief tubing: K copper.
   5. Size: As required.

B. Combination Strainer and Air Separator:
   1. ASME code constructed.
   2. Type: Tangential flow.
   3. Design pressure: 125 psig minimum at 350 DegF.
   4. Air collector tube.
      a. Stainless steel.
      b. 63 percent open area design (minimum).
   5. NPT vent connection.
   6. NPT blowdown connection.
   7. Tangential nozzles:
      a. NPT up to 3 IN DIA.
      b. Flanged, 4 IN and larger.
   8. Strainer:
      a. Galvanized steel.
      b. Free area not less than five (5) times the cross sectional area of the connecting pipe.
      c. Removable.
   9. GPM: As indicated.

C. Balancing Valve:
1. Type: Calibrated balance valve.
2. Connections:
a. NPT up to 3 IN DIA.
b. Flanged for 4 IN or larger.
3. Readout valve: Brass fitted with integral EPT insert and check valve.
4. Calibrated nameplate.
5. Integral seals.
6. Preformed polyurethane insulation.
7. Working pressure: 125 psig at 250 DegF minimum.

D. Readout Meter for Balancing Valves:
1. Type: Portable.
2. Range: 0 to 100 FT of water.
3. Increments: 0.5 FT.
4. Accuracy: +0.5 percent.
5. Accessories:
a. Carrying case.
b. 10 FT hoses.
c. Shut-off and vent valves.
d. Balance valve calculator.
6. Maximum operating temperature: 250 DegF liquids and gases.

E. Heating Water Pump:
1. Type: Centrifugal, single-stage, in-line type, in-line suction and discharge, base mounted.
2. Material:
a. Volute: Cast iron ASTM A159.
b. Impeller:
1) AA sizes: Brass, ASTM B36.
2) A, F sizes: Cast bronze, ASTM B584.
c. Pump shaft: Steel, SAE 1144.
d. Seal assembly:
1) Housing: Brass.
2) Bellows: Buna-N.
3) Ring: Carbon.
4) Spring: 304 stainless steel.
5) Seat: Ceramic.
6) Seat gasket: Buna-N.
e. Volute gasket: Cellulose fiber.
f. Companion flanges:
1) 1 to 1-1/2 IN: Formed steel.
2) 2 IN: Cast iron, ASTM A159.
g. Shaft sleeve: Copper alloy 110 or aluminum bronze, ASTM B584.
h. Motor:
1) Meets NEMA 4 requirements.
2) 3 HP, 480 V, 3 PH, 60 HZ.

F. Expansion Joints:
1. For piping 2-1/2 IN or smaller.
a. Type: Bellows.
b. Material:
1) Bellows: Two-ply stainless steel.
2) Shrouds and end fittings: Carbon steel.
c. Stroke: 1-3/4 IN compression, 1/4 IN extension minimum.
d. Maximum operating temperature: 750 DegF.
e. Maximum working pressure: 175 psi.
f. Maximum test pressure: 250 psi.

g. Fittings: NPT.

2. For piping 3 IN or larger:
   a. Type: Controlled flexing bellows.
   b. Material:
      1) Bellows: Stainless steel.
      2) Carrier rings and fittings: Steel.
   c. Maximum transverse travel: 7-1/2 IN.
   d. Temperature limits: -20 to 850 DegF.
   e. Allowable pressure: Vacuum to 300 psi.
   f. Fittings: Flanged.

G. Pipe Guides:
   1. Type: System consisting of a spider which rigidly attaches to pipe and is housed in a sleeve which can be rigidly anchored.
   2. Material: Steel.

H. Flexible Connectors:
   1. Type: Flexible corrugated single braid hose.
   2. Material: Stainless steel.
   3. Maximum working pressure: 150 psig.
   4. Maximum test pressure: 250 psig.
   5. Normal burst pressure: 650 psig minimum.
   6. Fittings:
      a. For sizes up to 2-1/2 IN DIA: NPT.
      b. For sizes 3 IN or larger: Flanged.

I. Hot water pumps to meet the following minimum requirements:
   1. Pump numbers: P-01.
      a. Design condition: 90 gpm at 61 FT/TDH.

1.6 FABRICATION

A. Fabricate pumps complete with motor and pump as one (1) unit.

1.7 SOURCE QUALITY CONTROL

A. Pump Impeller Trimming:
   1. Trim impellers to a diameter to provide design flow to each terminal with minimum pump power consumption for each pump.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Install hydronic specialty items where indicated or required.

B. Install at high point in closed water systems and at high point of coil headers an automatic relief vent.
   1. Install shut-off valve ahead of each vent.
   2. Extend relief tubing from vent to drippan or drain.

C. Install flexible connectors at pump suction and discharge and where indicated.

D. Install pipe guides in accordance with EJMA Standards.
   1. Space at 4 and 14 pipe diameters from expansion joints.
   2. Install at expansion loops as indicated.

2.2 FIELD QUALITY CONTROL

A. See Section 15990.

END OF SECTION

1

2014/08/28

SECTION 15605
HVAC: EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 15890 - HVAC: Ductwork.
   5. Section 15970 - Instrumentation and Control for HVAC Systems.
   6. Section 15990 - HVAC Systems: Balancing and Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Roofing Contractors Association (NRCA).
   8. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.
   9. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout Drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

c. Wiring diagrams.
d. Control diagrams.
e. Manufacturer's catalog cuts and technical data.
f. Fan curves.
g. Sound data.
h. Vibration isolation.
i. Control description.
j. Performance data on all equipment.

4. Certifications:
   a. Provide certification of thickness of corrosion-protection coating.

B. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Vibration isolation assemblies:
   a. Mason.
   b. Vibration Mounting and Controls Co.
   c. Vibro-Acoustics.
2. Heating and cooling coils - water - steam:
   a. Carrier.
   b. Daikin Applied.
   c. AAON.
3. Fan coils:
   a. Carrier.
   b. Daikin Applied.
   c. AAON.
4. Roof-mounted centrifugal exhaust fans:
   a. Loren Cook.
   b. Greenheck.
   c. PennBarry Ventilator Co., Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 GENERAL

A. All Manufactured Units:
1. Comply with Specification Section 11005.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
   a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
1. Type:
   a. Corrosion-resistant materials:
      1) Aluminum.
      2) Stainless steel.
      3) FRP.

2.3 MANUFACTURED UNITS

A. Equipment Coils:
   1. Heating and cooling coils - water - steam:
      a. ARI certified.
      b. Material:
         1) Aluminum.
         2) Copper with aluminum fins for use in administration units only.
      c. Fin spacing: Minimum 80 fins per foot.
      d. Minimum standard operating limit: 200 psi.
      e. Equip with vent, drain and condensate connections.
      f. Size and capacity as scheduled on Drawings.

B. Fan Coils:
   1. ARI certified.
   2. Coils: See paragraph(s) in Article 2.3, Equipment Coils.
   3. Blower:
      a. Fan wheels: Centrifugal forward-curved, double width.
      b. Fan housing: Galvanized steel.
      c. Statically and dynamically balanced.
      d. Motor:
         1) See Specification Section 11005.
         2) Integral overload protection.
   4. Cabinet:
      a. Material: Galvanized steel, 18 GA minimum.
      b. Exposed units equipped with hinged access panel, intake and discharge grilles.
      c. Concealed units equipped with return plenum, filter section and discharge duct collar.
   5. Drain pans:
      a. Material: Galvanized steel.
      b. Equip with drain connection.
      c. Insulated.
   6. Filters: See Specification Section 15890.
   7. Size and capacity as scheduled on Drawings.

C. Roof-Mounted Centrifugal Exhaust Fans:
   1. AMCA certified.
   2. Non-overloading horsepower capability.
   3. Materials:
      a. Top cap: Spun aluminum.
      b. Wheel and inlet shroud: Aluminum.
      c. Baffle: Aluminum.
      d. Base: One-piece aluminum.
      e. Drive assembly supports: Steel.
      f. Drive shaft: Solid stainless steel.
      g. Minimum 10 GA motor mounting plate.
   4. Backward inclined blades.
   5. Tapered inlet shroud.
   6. Statically and dynamically balanced wheel.
   7. Bearings:
      a. Cast iron pillow blocks.
      b. Concentric bearing locking collar for drive shafts 1 IN and larger.
         1) SKF "ConCentra."
         2) Dodge "D Lock."
      c. Regreaseable.
      d. 200,000 HR average life.
      e. Five-to-one load capability to actual load ratio.

8. Weathertight compartment for motor and drives.
    a. Separated from airstream.
9. Motor:
    a. See Specification Section 11005.
    b. Driver and driven sheaves:
        1) Keyed hub type.
        2) Drive sheaves: Fixed pitch diameter.
        3) Driver:
            a) Shipped with variable pitch diameter sheave.
            b) Fixed pitch diameter size based on approved test and balance reports.
        4) V-belt drives sized for 150 percent motor horsepower.
10. Automatic drive belt tensioner.
11. Vibration isolated drive assembly.
12. Accessories:
    a. Prefabricated insulated aluminum roof curb.
    b. Backdraft damper: See Specification Section 15890.
    c. Bird screen.
    d. Extended grease lines and fittings.
13. Size and capacity as scheduled on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Specification Section 11005.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 15990.

3.3 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

2014/08/14

SECTION 15710
HEAT EXCHANGERS AND CONVERTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liquid and vapor heat exchange equipment for heating, ventilating, and cooling equipment.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Section 15970 - HVAC Control System.
   5. Section 15990 - HVAC Systems - Balancing and Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Acoustical Society of America (ASA).
   2. American Society of Mechanical Engineers (ASME):
      a. Section VIII, Construction of Pressure Vessels - Division 1.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340.
   2. Fabrication and/or layout Drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's catalog cuts and technical data.
      d. Corrosion-protection information.
      e. Performance data on all equipment.
   4. Certifications: Provide certification of thickness of corrosion-protection coating.

B. Operation and Maintenance Manuals: See Section 01342.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Heat exchanger, plate:
      a. Base:
         1) Bell & Gossett.
         2) Alfa Laval Pumps.
         3) Patterson-Kelly.

4) Tranter.
2. Heat exchanger:
a. Double-wall plate and frame.
b. Base:
1) Bell & Gossett.

B. Submit requests for substitution in accordance with Specification Section 01640.

2.2 GENERAL

A. All manufactured units shall be factory assembled.

B. Units shall meet specific requirement, characteristics and capacities scheduled, noted, and indicated on the Drawings.

2.3 HEAT EXCHANGERS; PLATE

A. Instantaneous flat plat and frame type with corrugated heat transfer plates, support frame, nozzles, tightening mechanism, and sheet metal shroud.
1. Capacity as scheduled.
2. Maximum Operating Pressure: 150 psig.
3. Design temperature as scheduled.
4. Maximum Pressure Drop: As scheduled.
5. Plates: Stainless steel, herringbone type.
6. Heat Transfer Coefficient: Greater than 1000 BTU/HR/SF/DegF.
7. Plate Gaskets: EPDM, single piece, molded construction, bonded to plates.
8. Nozzles: 150 LB ASA rated flange type.
9. ASME Code construction.
10. Finish: Baked epoxy with manufacturer's standard color.

2.4 HEAT EXCHANGERS; DOUBLE-WALL, PLATE AND FRAME TYPE

A. Description:
1. A series of plates are hung from a carrier bar and clamped between fixed and moveable plates.
2. Gaskets between plates allow for fluid flow and distribution through main ports in each plate.
3. Hot and cold fluids are distributed through alternate plates in counter flow direction.
4. Moveable end plate allows separation of the plates for cleaning.
5. Each suspended plate is double walled, composed of two (2) thin plates, welded together at the port openings, with the outside edges open, allowing any fluid from a possible leak to drip outside, alerting the user.

B. Capacity as indicated.
1. Provide space 20 percent additional plates for expansion and to facilitate cleaning.

C. ASME Code constructed and stamped for the pressure indicated.

D. All surfaces exposed to fluid constructed of stainless steel, including the top, plate hanger bar and the bottom guide bar.

E. Protective shroud to be stainless steel.

F. Unit is factory assembled and tested.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Section 11005.

3.2 FIELD QUALITY CONTROL

A. Comply with Section 15990.

3.3 ADJUSTING

A. Comply with Section 15990.

END OF SECTION

1

2014/08/14

SECTION 15890
HVAC: DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: HVAC ductwork and accessories.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 10200 - Louvers and Vents.
4. Section 11005 - Equipment: Basic Requirements.
5. Section 15970 - Instrumentation and Control for HVAC Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
2. National Fire Protection Association (NFPA).
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
a. Ducted Electric Heat Guide for Air Handling Systems.
b. HVAC Duct Construction Standards - Metal and Flexible.
4. Underwriters Laboratory, Inc. (UL):
a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.
c. Building Materials Directory.
5. Building Code:
a. International Code Council (ICC):
1) International Building Code and associated standards, 2003 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three (3) years.
2. Installers: Firm with at least five (5) years installation experience on products similar to that required for this Project.

1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 11005.
3. Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.

4. Scaled ductwork Drawings (1/4 IN equals 1 FT) showing duct and accessory layout and support.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittal:
   1. Documentation of qualifications for fabricators and installers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Transverse joints (factory fabricated aluminum):
      a. Ductmate Industries, Inc.
   2. Turning vanes:
      a. Ductmate Industries, Inc.
      b. Duro Dyne.
      c. SEMCO Incorporated.
      d. Ward Industries, Inc.
   3. Grilles and registers:
      a. Anemostat.
      b. Carnes.
      c. Titus.
   4. Air filters:
      a. American Air Filter.
      b. Farr.
      c. Continental.
   5. Manual (volume) dampers:
      a. Air Balance.
      b. Ruskin.
      c. American Warming.
   6. Duct sealers:
      a. Chicago Mastic.
      b. 3M Co.
      c. Permatex.
      d. Benjamin Foster.
   7. Louvers:
      a. Ruskin.
      b. Air Balance.
      c. American Warming.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 COMPONENTS

A. Duct and Fittings (Metallic):
   1. Materials: 3003 H-14 aluminum alloy.
   2. Fabrication:
      a. Minimum sheet material thickness:
         1) Ducts with largest side or diameter to 30 IN: 0.05 IN thick.
         2) Ducts with largest side or diameter greater than 30 IN: 0.08 IN thick.

b. Utilize SMACNA HVAC Duct Construction Standards for minimum of 2 IN water gage static pressure for the minimum sheet material thickness specified herein.
    1) Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.
    2) Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.
c. Longitudinal seams:
    1) 0.050 material:
        a) Pittsburgh seam.
        b) Continuously welded.
    2) 0.080 material: Continuously welded.
d. Continuously weld seams on factory assembled units.
e. Transverse joints (Alternate A):
    1) SMACNA T-22 companion flange.
    2) Gasketed.
    3) Rigidity class:
        a) Ducts with largest side or diameter to 30 IN: SMACNA Class D (1-1/2 x 1-1/2 x 1/8 IN angles).
        b) Ducts with largest side or diameter greater than 30 to 54 IN: SMACNA Class H (2-1/2 x 2-1/2 x 3/16 IN angles).
f. Transverse joints (Alternate B):
    1) Materials and fabrication:
        a) Angles: Aluminum.
            (1) Ductmate 35.
        b) Corners: Aluminum.
            (1) Ductmate DC 35.
        c) Snap cleats: Aluminized or stainless steel.
        d) Gaskets: Closed cell neoprene.
        e) Bolts: Stainless steel.
        f) Sheet metal screws: Self-drilling stainless steel with unthreaded section under head.
    2) Fabrication:
        a) Rigidity class: SMACNA Class H.
        b) 3/8 IN DIA x 1 IN bolts.

B. Supports and Hangers:
1. Materials:
    a. Support angles: Aluminum or stainless steel.
    b. Hanger rods: Stainless steel.
    c. Anchors: Stainless steel wedge type.
2. Fabrication: Trapeze type units.

C. Turning Vanes:
1. Materials: Same as duct.
2. Fabrication:
    a. Fabricate double vane units.
    b. Pressure drop through elbows: Maximum 20 percent of velocity pressure.

D. Air Grille and Register Assembly:
1. Materials:
    a. Assembly: Extruded aluminum.
    b. Gaskets: Sponge rubber.
2. Fabrication:
    a. Supply registers: Two (2) sets individually adjustable louvers.
    b. Exhaust and return registers: 45-degree deflection front blades.
    c. Dampers: Key-operated opposed blade.
    d. Screws, duct collars, and transitions as required.

e. Finish:
1) Manufacturer's standard factory applied finish.
2) Color: White.

E. Air Filter Enclosure:
1. Housing:
a. Factory fabricated.
b. 16 GA galvanized steel.
c. Bracing to eliminate racking.
d. Two-side access doors.
2. Access doors:
a. 16 GA galvanized steel.
b. Replaceable positive sealing latches.
c. Replaceable hinges.
d. Neoprene door gasket.
e. Holding frame to door gasket: Polyurethane foam.
3. Tracks:
a. Field adjustable.
b. Anodized extruded aluminum.
c. Polypropylene seal between holding frame and track.
4. Holding frame:
a. Galvanized steel.
b. Multiple fastener lances.
c. Polyurethane foam gasket.
1) Internally.
2) Frame sides.
d. Accommodate nominal 24 x 24 IN or 12 x 24 IN filters without modifications to frame or housing.

F. Air Filters:
1. Materials:
a. Holding frame: Aluminum.
2. Fabrication:
a. Factory built and assembled unit.
b. Efficiency rating as per ASHRAE 52.
c. 2 IN thickness minimum.
d. Efficiency: 20 percent.
e. Air velocity: 450 FPM maximum.
f. Clean pressure drop: 0.2 IN WG maximum.
g. Size, capacity, and type: As indicated on Drawings.

G. Temperature Control, Automatic and Manually (Volume) Operated Dampers:
1. Material:
a. Body: 6063 T5 aluminum.
b. Seal blade edge: Extruded vinyl.
2. Fabrication:
a. Frame thickness: 0.125 IN minimum.
b. Provide flanged connections.
c. Blades:
1) Two-position damper: Parallel blade.
2) Mixing and volume damper: Opposed blade.
3) Airfoil shape.
4) Maximum 6 IN width.
d. Linkage: Concealed in frame.
e. Axles: 1/2 IN plated steel hex.
f. Bearings: Molded synthetic.

g. Seals:
1) Jamb: Flexible compression type.
h. Control shaft: Removable, 1/2 IN DIA.
i. Air leakage (4 FT SQ damper) at 4 IN WG pressure: 99 cfm maximum.
j. Motors for motor operated damper: See Specification Section 15970.
k. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.
l. Provide stainless steel locking quadrants for manual (volume) dampers.
m. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.
n. Finish: 215 R1 anodized.

H. Louvers: See Specification Section 10200.

2.3 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Owner with the following extra materials:
a. Twelve complete filter media changes for each filter unit.
b. Filter media used during construction is in addition to this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 11005.

B. Metal Ductwork:
1. Install with longitudinal seams sealed for zero leakage.
a. For welded seams, submit sample for approval by Engineer.
2. Install gaskets at each transverse joint and fasten sections together with bolts.
a. Tighten for zero leakage.
3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
4. Install turning vanes in square elbows:
a. Unsupported vane length not to exceed 48 IN.
b. Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
a. Locate as close as possible to fan.
b. Allow 1 IN of slack to prevent vibration transmission.
c. Install thrust restraints across connectors.
6. Install access doors where indicated on Drawings and at smoke and fire damper in accordance with NFPA requirements.
7. Volume extractors:
a. Install at supply registers, grilles, diffusers and supply branch connections from ducts.
b. Provide branch duct extensions into main duct above and below extractor when branch duct is narrower than main duct.

C. Dampers:
1. Install where indicated on Drawings of sizes shown.
2. Install fire and smoke dampers in ductwork passing through 1 HR or higher fire-rated construction.
a. Install in wall and floor openings utilizing steel sleeves, angles and other materials following practices required to provide installation in accordance with local Building Codes.

D. Air Grille and Register Assemblies:
1. Install where shown on Drawings of size and capacities scheduled on Drawings.

2. Install prime painted grilles and registers in areas where duct work is concealed.
    a. Field paint to match adjacent surface finish.

E. Air Filters:
1. Install where shown on Drawings of size and capacity scheduled on Drawings.
2. Do not operate equipment during construction without filters.

END OF SECTION

2014/08/28

SECTION 15970
INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Instrumentation and control for HVAC systems.
2. Temperature control.
3. Ventilation control.
4. Heating control.
5. Cooling control.
6. Control wiring.
7. Panels and accessories.
8. Miscellaneous.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 10400 -Identification Devices.
4. Section 11005 - Equipment: Basic Requirements.
5. Section 13440 - Instrumentation for Process Control: Basic Requirements.
6. Section 15605 - HVAC: Equipment.
7. Section 15890 - HVAC: Ductwork.
8. Division 16 - Electrical.

1.2 QUALITY ASSURANCE

A. See Specification Section 11005.

B. Referenced Standards:
1. ASTM International (ASTM):
   a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
2. Instrumentation, Systems, and Automation Society (ISA):
   a. S5.1, Instrumentation Symbols and Identification.
   b. S5.4, Standard Instrument Loop Diagrams.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL).

C. Miscellaneous:
1. Controls to be in compliance with Specification Section 16010 for NEMA and NFPA 70 enclosure class requirements unless noted or specified otherwise.
2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

1.3 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.
   1. Assemble control system with complete system of wiring and air piping to fulfill requirements of the Contract Documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operation," are designed to illustrate operating functions only.
   1. Control sequence shall be considered supplementary to "Sequence of Operation."
   2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.

E. Sequence of Operation - General:
   1. Sequence of operation indicated illustrates basic operating functions only.
   2. Contractor shall review Drawings and submit complete installation data, including minor details, to provide proper operation in his proposal.
   3. Where an item differs from specifications, control manufacturer shall submit manufacturer's recommendations subject to Engineer's approval.
   4. Collector Well:
      a. AHU-01.
         1) Circuited from MSB01.
         2) Controlled by HOA switch.
            a) HAND: AHU-01 fan is “ON”.
            b) OFF: AHU-01 fan is “OFF”.
            c) AUTO: AHU-01 is controlled by a wall-mounted thermostat.
               (1) Maintain summer cooling set point of 80 DegF (adjustable).
               (2) Maintain winter heating set point of 60 DegF (adjustable).
      b. P-01 and P-02:
         1) Circuited from MSB01.
         2) Controlled by contacts from AHU-01.
            a) Pumps will turn on after receiving a signal from AHU-01 calling for heating or cooling.
      c. EF-01 and SF-01.
         1) Circuited from LP2.
         2) Controlled by HO switch.
            a) HAND: EF-01 and SF-01 are “ON”.
            b) OFF: EF-01 and SF-01 are “OFF”.
      d. MOD-01.
         1) Circuited from LP2.
         2) Controlled by HOA switch.
            a) HAND: MOD-01 is “OPEN”.
            b) OFF: MOD-01 is “CLOSED”.
            c) AUTO: MOD-01 is controlled by wall-mounted thermostat.
               (1) Above set point 85 DegF (adjustable): MOD-01 is “OPEN”.
               (2) Below set point 85 DegF (adjustable): MOD-01 is “CLOSED”.
      e. EF-02.
         1) Circuited from LP2.
         2) Controlled by end switch on MOD-01.
            a) MOD-01 is “OPEN”: EF-02 is “ON”.
            b) MOD-01 is “CLOSED”: EF-02 is “OFF”.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
   3. Pneumatic piping diagrams.
   4. Information on equipment proposed for use including corrosion protection.
   5. Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.
      a. Show components in system and ensure diagrams are in full compliance with ISA S5.1 (Instrumentation Symbols and Identification) and other related ISA standards.

B. Quality Control Submittals:
   1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
      a. Provide the above information to control manufacturer.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.5 SITE CONDITIONS

A. Unless stated otherwise, the environment and air streams will include varying concentrations of the following chemical components:
   1. Condensation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Manufacturer's catalog numbers hereinafter are for reference to type, style, dimension, related items and to establish a standard of quality.
      a. Reference to a manufacturer's number hereinafter does not imply full compliance to these Specifications.
   2. Instrumentation and control systems:
      a. Honeywell.
      b. Johnson Control Co.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 EQUIPMENT

A. Dampers: Refer to Specification Section 15890.

B. Damper Operators:
   1. Provide operators of proper size and number to secure true throttling or two-position action as required.
   2. Furnish damper operators for installation inside ductwork and attached to frame of damper, or installed outside ductwork and connected to extended shaft as required.
   3. Provide operators for outside air, spring-loaded with sufficient power to assure tight closing of dampers on fan shutdown or in the fail safe position indicated by "Sequence of Controls."

4. Electric operators:
    a. Provide operators:
        1) Fully immersed in oil gear train.
        2) Enclosed in closed cast aluminum housing.
    b. As an alternate to 5.a.: Provide operators in NEMA 4X enclosure, Belimo ZS-300.
    c. Provide damper operators with integral spring return motor springs to make controls fail safe in position specified under "Sequence of Controls."
    d. Provide fully modulating operators from proportional electric controllers.
    e. Provide end switches or proportioning controllers permitting simultaneous operation or interlocking with other equipment.
    f. Provide separate electrical circuits for damper operators with no more than four (4) operators on a circuit.
5. Coordinate with dampers provided:
    a. Provide damper operators that are rated for the required torque.
    b. If single damper operator can not meet torque requirement, provide sectional dampers to match operator torque.
6. Use of electric operators shall be limited to small dampers in those applications where it is impractical to provide pneumatic operators and are to be approved by the Engineer.
7. Ensure coordination to provide for the installation of tight closing dampers low leakage type (6 cfm per square foot at 4 IN WC pressure across damper) with compatible dampers, damper operators and related controls.

C. Electric Control Instruments:
1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
    a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.
    b. Provide sensing elements minimum of 60 IN in length and suitable for operation from -30 to 300 DegF.
    c. Provide reverse acting on-off type thermostats for controlling ventilating fans.
    d. Provide multiple stage thermostats where designated in Paragraph "Sequence of Operation."
2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125 percent of energy requirements of equipment connected for not less than 1 HR.
    a. Enclose transformers in UL listed cabinets with conduit connections.
    b. Provide fused disconnect switches on both primary and secondary sides.
    c. Provide in full compliance with Division 16 Specification Sections.
3. Provide low limit electric thermostats of two-position type with 20 FT bulb and manual reset.
    a. Shall be capable of opening thermostat circuit if any 1 FT section of bulb is subjected to a temperature below thermostat setting.
    b. Each thermostat shall have two (2) circuits, one (1) to shut down fan, another for alarm.
    c. Install all freeze-stats to override starter circuits regardless of position.
    d. For corrosive environments provide thermostats with stainless steel sensing elements.
        1) Ensure element is installed to sense coldest point should stratification occur.
4. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.
5. Label thermostat with identification tag of HVAC equipment controlled using phenolic nameplate in accordance with Specification Section 10400.

D. Industrial Controllers:
1. Provide control instruments, devices, and incidentals of industrial process control quality capable of producing the outlined performances.
2. Controller shall be capable of receiving both pneumatic and analog electric systems.

3. The pneumatic controller shall have three (3) control mode capabilities of proportional, automatic reset, and rate (derivative) within following minimum performance and application criteria:
    a. Proportional band: 1 to 40 percent.
    b. Reset rate: 1 to 20 repeats per minute.
    c. Rate (derivative): 0.1 to 15 minutes.
    d. Hysteresis: Less than 0.25 percent of span.
    e. Tracking accuracy: Within 0.5 percent of span.
    f. Repeatability: Within 0.1 percent of span.
    g. Response level: Less than 0.01 percent of span.
4. Electronic (and electric) controller shall have three (3) control mode capabilities of proportional rate (time), and dead band within following minimum performance and application criteria:
    a. Setpoint adjustment: 0 to 110 percent of span.
    b. Repeatability: Setpoint repeats within +0.1 percent of span.
    c. Dead band: 1 percent of span, standard.
    d. Rate: 5 to 30 seconds adjustable.
    e. Response level: 50 milliseconds for a step change of 1 percent of span beyond setpoints.
    f. Output: SPDT relay contacts, 5 amps at 117 Vac noninductive.
5. Controller shall be capable of remote setpoint adjustment, permanently mounted in air flow control panel unless otherwise indicated.
6. Provide each controller with instruments (pressure gages, milliampmeters, voltmeters, etc.) to indicate magnitude of output signal in both medium of signal (psig, mA, volt DC, etc.) and percentage of full output signal.
7. Recording controllers:
    a. Where recording controllers are required by "Sequence of Controls," they shall be 10 IN chart, 24 HR or 30-day charts (field selection), with one (1), two (2), or three (3) pens as listed in control sequence.
    b. Pens shall have capillary ink supply and cartridge type ink supply.
    c. Recorders shall operate on 110 V power supply.
    d. Optional 4 IN strip chart recorders may be used with the strip traveling vertically.

E. Static Pressure Gages:
1. Install gages on control panel for each system.
    a. One (1) gage shall serve each filter while others shall serve as a check on system.
    b. Gages shall be Magnahelic by Dwyer 2000 ASF, flush mounted with signal flag for filter gage.
    c. Install static pressure tips as scheduled under control panel indication points.
    d. Static pressure ranges:
        1) Filter (cartridge): 0 to 2.0 IN WC.
        2) Air-handling systems: 0 to 10.0 IN WC (one (1) per air-handling unit).

F. Local Temperature Control Panel:
1. Panel shall be floor or wall-mounted and be sized to accommodate electrical switches, protective devices (except electrical switches and devices furnished as an integral part of air handling unit).
2. Mount indicating controllers or receiver-controllers, three-way air valves, relay, EP and PE switches, switching relays, ammeters and other accessory items on local sub-panels set in vicinity of equipment to be served.
    a. Where two (2) similar items of equipment, such as pumps, are installed adjacent to each other a single panel may be used to contain all instruments.
3. Fully compensated capillaries connected to instruments shall be of sufficient length to allow them to be run between equipment and placed in such a position so that they will not obstruct service of equipment or become damaged.

4. Air pressure gages for pneumatic controls of at least 2 IN in diameter shall be provided for indication of transmitter signals and output signal of all controllers, relays, EP switches, outdoor air dampers, PE switches, control valves larger than 4 IN and other points throughout system.
    a. Provide visual indication for operating purposes.
    b. Temperature and pressure indicating gages where scheduled for panel door mounting shall be not less than 2-1/2 IN in diameter, flush mounted with accuracy of +1 DegF.
    c. Where a temperature indication gage is used, a pressure gage is not required for same signal.
    d. Transmitter signal and controller output gages shall be in-line mounted or mounted on controllers if provided with tapped connections.
    e. One (1) or more permanently mounted gages with flexible hose terminating in a hypodermic needle may be used for checking other parts of control signals; however, signal connections may not be used as a substitute for in-line mounted gages.
    f. All gages and instruments shall be suitably tagged with their function.
5. Miniature milliamp meters for electronic temperature transmission may be used.
6. Manufacture panels in one (1) of the following manners:
    a. NEMA electrical panel boxes with windows.
    b. Install gages flush mounted in swing out panel behind window with instruments and other control items located inside enclosures behind panel.
        1) Refer to Paragraph "Corrosion Protection."
7. Mount all relays, PE switches, pressure switches, etc., on rear inside of enclosure.
    a. Tag each instrument corresponding to symbols used on control diagrams.
8. Temperatures, pressures, equipment operation, and related items shall be continuously indicated on panels.
9. Points to be monitored are scheduled under another paragraph of this Specification Section.

2.3 FABRICATION

A. Corrosion Protection:
    1. Protect metal parts of controls, instrumentation and related items from corrosive atmosphere by either protective coatings or select materials.
        a. Aluminum and stainless steel require no further protection.
    2. Provide NEMA 4X fiberglass control enclosures with tempered glass windows and vapor tight gaskets, illustrated in Hoffman Bulletin A-50, for protection of controls from corrosive environment.
        a. Install control instruments inside enclosure and extend remote stainless steel sensing elements through enclosure wall.
        b. Provide vaportight seals for penetrations of enclosure.
    3. Provide in each enclosure industrial corrosion inhibitors, Hoffman Corrosion Inhibitors, as illustrated in Hoffman's technical Bulletin HCI.
    4. Protect metal accessory items such as mounting brackets and fasteners not stainless steel, fiberglass or aluminum by epoxy or phenolic coatings.
    5. Protect electric motor operator with corrosion inhibitors inside enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Specification Section 16120 and Specification Section 16130.

B. Identification: See Specification Section 10400.

C. Connect control devices to perform functions indicated and perform in required sequence.

D. Use remote element temperature transmitters for points of temperature transmitters for points of temperature measurement occurring in air ducts or shafts, or in mechanical piping system.

E. Use remote element pressure transmitters of panel-mounted pressure gages.

F. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.
   1. Pipe continuous indication signal to a receiver on panel.
   2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.

G. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.
   1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
   2. Prior to installation, coordinate thermostat location with Engineer.

H. Mount local control panels adjacent to equipment served.

I. Where a temperature indicating gage is used at the panel, a pressure gage indicating transmitter signal is not required.

J. Provide appropriate type continuous reading indicator for each controller, transmitter and transducer.
   1. Mount in-line or tapped on controller.
   2. Mount at local control panel.

K. Gages with flexible hose terminating with hypodermic needle may be used for checking control system.
   1. Do not substitute for in-line gages.

L. Locate panels so visual observation and adjustment can be accomplished from floor level.

END OF SECTION

1

2014/08/14

SECTION 15990
HVAC SYSTEMS: BALANCING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems, including the following systems:
      a. Air distribution and exhaust systems.
      b. Air moving equipment.
      c. Circulating water systems, including pumps.
      d. Control systems.
      e. Chilled water system.
      f. Heating system.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15605 - HVAC: Equipment.
   4. Section 15890 - HVAC: Ductwork.
   5. Section 15970 - Instrumentation and Control for HVAC Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   2. American Industrial Hygiene Association (AIHA):
      a. Z9.5, Laboratory Ventilation.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Laboratories."
      b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing."
   4. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:
   1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
      a. Associated Air Balance Council (AABC).
      b. National Environmental Balancing Bureau (NEBB).
      c. Other certification entity approved by Engineer.
   2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certifications:
      a. Letter stating the name and qualifications of the firm proposed.

b. Evidence that relevant subcontractors have been notified of the requirement to coordinate balance and test elements in the work with the testing and balancing firm.

3. Report forms:
   a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

B. Informational Submittals:
1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
   a. Insert recorded information on report forms required by specifications and approved for use on project.
   b. Additional written verification and other related information clearly identifying project, date and specifics of verification.
   c. Utilize report forms similar to those shown in Section V of AABC Standard.
   d. Provide forms typed and signed by the testing and balancing firm.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:
1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.
2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.
1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review design Drawings, specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.
1. Report deficiencies to the Engineer.
2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

3.2 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:
1. Adjust equipment RPM to design requirements.
2. Report motor full load amperes.
3. Obtain design CFM at fans.
   a. Make pitot tube traverse of main supply and exhaust ducts within 5 percent.
4. Test and record system static pressures, suction and discharge.
5. Obtain design CFM for recirculated air.
6. Obtain design CFM outside air.
7. Test and record entering air temperatures, (DB, heating and cooling).

8. Test and record leaving air temperatures, (DB, heating and cooling).
9. Test and record leaving air temperatures, (WB, cooling).
10. Adjust dampers in supply, exhaust and return air ducts to design CFM.
11. Test diffusers, grilles, and registers as follows:
    a. Adjust to comply with design requirements within 10 percent.
    b. Identify location and area of each.
    c. Adjust face velocity to establish required CFM.
        1) Retest after initial adjustments.
    d. Adjust to minimize drafts and to ensure uniform air distribution in all areas.
12. Identify and list size, type and manufacturer of diffusers, grilles, registers, and HVAC equipment.
    a. Use manufacturer's ratings on equipment to make required calculations.
13. Adjust and assure that the operation of automatically operated dampers are as specified.
    a. Check and calibrate controls.
14. Prepare and submit reports.

B. Balance and Test Water Systems:
    1. Phase 1:
        a. Complete air balance before beginning actual water balance.
        b. Open valves to full open position.
            1) Close coil bypass stop valves.
            2) Set mixing valve to full coil flow.
        c. Check operation of relief valves.
        d. Examine water in system and determine if water has been treated and cleaned.
            1) Clean strainers before and after balancing.
        e. Check pump rotation.
        f. Check expansion tanks to determine they are not air bound and system is completely full of water.
        g. Check air vents at high points of water systems and determine all are installed and operating correctly.
        h. Set temperature controls so coils are calling for full heating.
            1) This should close automatic bypass valves.
            2) Utilize same procedure when balancing chilled water coils, set on call for full cooling.
        i. Check operation of automatic bypass valves.
    2. Phase 2:
        a. Set pumps to proper flow delivery.
        b. Adjust and record waterflow at system entrance.
        c. Adjust and record waterflow through pumps.
        d. Check and record water entering temperatures and return water temperatures at system entrance.
            1) Set to correct design temperatures.
        e. Check water temperatures at inlet side of cooling and heating coils.
            1) Record rise or drop of temperatures from source.
        f. Proceed to balance each chilled water and hot water coil.
        g. Upon completion of flow readings and adjustments at coils, mark settings and record data.
    3. Phase 3:
        a. After adjustments to coils are made, recheck settings at pumps and readjust if required.
        b. Install pressure gauges on coil, read pressure drop through coil at set flowrate.
            1) Set pressure drop across bypass valve to match coil full flow pressure drop to prevent unbalanced flow conditions when coils are on full bypass.
        c. Check and record the following items at each cooling heating element:
            1) Inlet water temperatures.
            2) Leaving water temperatures.
            3) Pressure drop of each coil.

4) Pressure drop across bypass valve.
5) Pump operating suction and discharge pressures and final TDH.
6) Water metering device readings.

d. List mechanical specifications of pumps.

e. Record rated and actual running amperage of pump motor.

f. Prepare and submit report.

END OF SECTION

DIVISION 16

ELECTRICAL

2014/08/14

SECTION 16010
ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 11005 - Equipment: Basic Requirements.
   5. Division 16 - Electrical.
   6. Section 16120 - Wire and Cable - 600 Volt and Below.
   7. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
   3. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of submittal process.
   2. See Specification Section 11005 and individual specification sections for submittal requirements for products defined as equipment.

3. General requirements:
    a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
    b. Include data sheets that include manufacturer's name and product model number.
        1) Clearly identify all optional accessories.
    c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
    d. Manufacturer's delivery, storage, handling and installation instructions.
    e. Product installation details.
    f. See individual specification sections for any additional requirements.
4. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.

B. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01340 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01600.

B. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
1. Outdoor areas:
    a. Wet.
2. Indoor areas:
    a. Dry.
    b. Also, wet, when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Division 16 Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Submit request for substitution in accordance with Specification Section 01640.

C. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
1. Approved manufacturers:
    a. Modular strut:
        1) Unistrut Building Systems.
        2) Eaton B-Line.
        3) Globe Strut.
        4) Thomas & Betts Superstrut.

2. Material requirements:
    a. Modular strut:
        1) Stainless steel: AISI Type 316.
        2) Aluminum: AA Type 6063-T6.
    b. Mounting plates:
        1) Aluminum: AA Type 6063-T6.
    c. Mounting hardware:
        1) Stainless steel.
    d. Anchorage per Specification Section 05505.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
    1. NFPA 70.
    2. IEEE C2.
    3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.
    1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
    2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
    1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
    2. The Contractor shall furnish and install all conduit and conductors required for proper operation of the circuit.
    3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
    4. See Specification Section 16120 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceeds dimensions or reduces clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:
    1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
        a. Light switch (to center): 48 IN.
        b. Receptacle in non-architecturally finished areas (to center): 48 IN.
        c. Safety switch (to center of operating handle): 54 IN.
        d. Separately mounted motor starter (to center of operating handle): 54 IN.
        e. Pushbutton or selector switch control station (to center): 48 IN.

f. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
      a. 1 FT at grade, floor and roof level in any direction in the horizontal plane.
      b. 1 FT for equipment other than lighting at ceiling level in any direction in the horizontal plane.
      c. 1 FT for lighting fixtures at ceiling level in any direction in the horizontal plane..
      d. 1 FT on walls in a horizontal direction within the vertical plane.
      e. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
   2. Wet areas:
      a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 05505.
   2. Do not cut, or weld to, building structural members.
   3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components in accordance with Specification Section 10400.

3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
   1. See Specification Section 01800 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:
   1. See Specification Section 01710.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.

3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
4. Repair surfaces which will be inaccessible after installation prior to installation.
5. See Specification Section 16130 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01650.

END OF SECTION

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SECTION 16060
GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Material and installation requirements for grounding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 02444 - Chain Link Fence and Gates.
   4. Section 10400 - Identification Devices.
   5. Section 16010 - Electrical: Basic Requirements.
   6. Section 16080 - Acceptance Testing.
   7. Section 16120 - Wire and Cable - 600 Volt and Below.
   8. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
         1) Article 250, Grounding and Bonding.
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. Burndy.
      b. Harger Lightning Protection.
      c. Heary Brothers.
      d. Joslyn.
      e. Robbins Lightning Protection.
      f. Thomas & Betts Blackburn.
      g. Thompson.
   2. Exothermic weld connections:
      a. Erico Products Inc., Cadweld.
      b. Harger Lightning Protection.
      c. Thermoweld.
      d. Thomas & Betts Furseweld.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 COMPONENTS

A. Wire and Cable:
   1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
   2. Insulated conductors: Color coded green, per Specification Section 16120.

B. Conduit: As specified in Specification Section 16130.

C. Ground Bars:
   1. Solid copper:
      a. 1/4 IN thick.
      b. 2 IN wide.
      c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
   2. Predrilled grounding lug mounting holes.
   3. Stainless steel or galvanized steel mounting brackets.
   4. Insulated standoffs.

D. Ground Rods:
   1. 3/4 IN x 10 FT, or as indicated on the Drawings.
   2. Copperclad:
      a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
      b. Corrosion resistant bond between the copper and steel.
      c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:
   1. Mechanical type:
      a. Standards: UL 467.
      b. High copper alloy content.
   2. Compression type for interior locations:
      a. Standards: UL 467.
      b. High copper alloy content.
      c. Non-reversible.
      d. Terminals for connection to bus bars shall have two bolt holes.
   3. Compression type suitable for direct burial in earth or concrete:
      a. Standards: UL 467, IEEE 837.
      b. High copper alloy content.
      c. Non-reversible.

F. Exothermic Weld Connections:
   1. Copper oxide reduction by aluminum process.
   2. Molds properly sized for each application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
   3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
   4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install per Specification Section 01800.
   5. Do not splice grounding conductors except at ground rods.
   6. Install ground rods and grounding conductors in undisturbed, firm soil.
      a. Provide excavation required for installation of ground rods and ground conductors.
      b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
      c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
      d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
      e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
   7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
   1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
   2. Grounding conductor terminations:
      a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
      b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
      c. Piping systems use mechanical type connections.
      d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.
      e. At all above grade terminations, the conductors shall be labeled per Specification Section 10400.
   3. Triad grounding system:
      a. Triad consists of three ground rods arranged in a triangle separated by 10 FT and a grounding conductor interconnecting each ground rod.
      b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
      c. Grounding conductor: Bare conductor, size as indicated on the Drawings.

C. Supplemental Grounding Electrode:
   1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
   2. Equipment support rack and pedestals mounted outdoors:
      a. Connect metallic structure to a ground rod.
      b. Grounding conductor: #6 AWG minimum.

3. Engine generator:
    a. Connect generator frame to the ground ring at two locations (opposite corners of frame).
    b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

D. Other Bonding Requirements:

E. Low Voltage Transformer Separately Derived Grounding System:
1. Ground separately mounted step-down transformers XO terminal to one of the following:
    a. Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic weld.
    b. Ground bar.
2. Grounding bar: 1 FT in length and mounted in electrical room or adjacent to transformer.
3. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar.
    a. Terminate the conductors on ground bars with a compression type terminal and bolt it to the ground bar with two bolts.
    b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

F. Raceway Bonding/Grounding:
1. All metallic conduit shall be installed so that it is electrically continuous.
2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

G. Equipment Grounding:
1. All utilization equipment shall be grounded with an equipment ground conductor.
2. Use generator manufacturer's provisions for grounding electric generators, or manufacturer's written instructions, except as shown on the Contract Drawings.

H. Cable Tray Grounding:
1. Make metal cable tray electrically continuous by one of the following methods:
    a. Tray sections and fittings suitable for grounding purposes.
    b. Provide bonding jumpers at discontinuous joints.

I. Manhole and Handhole Grounding:
1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
    a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

J. Fence grounding: See Specification Section 02444.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance Testing: See Specification Section 16080.

END OF SECTION

2014/08/28

SECTION 16080
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.
   4. Division 16 - Electrical.
   5. Section 16230 - Engine Generator - Diesel.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
      b. 400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field Environment.
   2. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   3. Nationally Recognized Testing Laboratory (NRTL).
   4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibers - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Testing firm qualifications: See Specification Section 11005.
   2. Field personnel:
      a. See Specification Section 11005.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.
   3. Analysis personnel:
      a. See Specification Section 11005
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

2. See Specification Section 11005 for electrical equipment and connection testing plan submittal requirements.

B. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Prior to energizing equipment:
      a. Coordinated phasing diagram.
      b. Photocopies of continuity tests.
   3. Within two (2) weeks after successful completion of Demonstration Period (Commissioning Period):
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.
         3) See testing and monitoring reporting requirements in Specification Section 11005.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Division 16 equipment with all routing factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 11005.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. See Specification Section 11005.
   2. Complete electrical testing in three (3) phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   3. Perform testing in accordance with this Specification Section and NETA ATS.
   4. Provide field setting and programming of all adjustable protective devices and meters to settings provided by the Engineer.

B. Equipment Monitoring and Testing Plan: See Specification Section 11005.

C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 11005.

D. Testing and Monitoring Program Documentation: See Specification Section 11005.

E. Electrical Equipment and Connections Testing Program:
   1. See Specification Section 11005.
   2. See individual Division 16 Specification Sections for equipment specific testing requirements.
   3. Test all electrical equipment.
      a. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.
   4. See Schedule at the end of PART 3 for equipment to be tested and specific test requirements.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchgear and Switchboards:
   1. Perform inspections and tests per NETA ATS 7.1.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following additional tests:
      a. Weatherproof switchgear/switchboards:
         1) Verify correct location, operation and current draw of heaters.
         2) Verify correct operation of thermostat.

B. Transformers - Small Dry Type:
   1. Perform inspections and tests per NETA ATS 7.2.1.1.
   2. Perform the following additional tests:
      a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
   3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Engineer.
   4. Record as-left tap connections.

C. Cable - Low Voltage:
   1. Perform inspections and tests per NETA ATS 7.3.2.

D. Cable - Optical Fiber:
   1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
      a. Optional time domain reflectometer test.
      b. Power attenuation test.
      c. Gain margin test.

E. Low Voltage Molded Case Circuit Breakers:
   1. Perform inspections and tests per NETA ATS 7.6.1.1.
   2. Components:
      a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
      b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
      c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
   3. Record as-left settings.

F. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

G. Ground Fault Protection:
   1. Perform inspections and tests per NETA ATS 7.14.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
   4. Perform the following additional tests for four-wire systems:
      a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
      b. Verify no tripping for unbalanced load on each feeder and each main breaker.
      c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
      d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.

e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

H. Motors:
1. Perform inspections and tests per NETA ATS 7.15.
2. See Specification Section 11005.

I. Motor Controllers:
1. Perform inspections and tests per NETA ATS 7.16.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

J. Generators:
1. Perform inspections and tests per NETA ATS 7.15.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
a. Load and cycle crank test per Specification Section 16230.

K. Control System Functional Test:
1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
b. Verify the correct operation of all sensing devices, alarms and indicating devices.
c. Standby Generator Systems.
d. Automatic Transfer Switch Schemes.

END OF SECTION

2014/08/28

SECTION 16120
WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Shielded VFD cable.
      e. Instrumentation cable.
      f. Fiber optic cable.
      g. Wire connectors.
      h. Insulating tape.
      i. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16080 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA):
      a. 598-C, Optical Fiber Cable Color Coding.
   6. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 486C, Standard for Safety Splicing Wire Connections.
      f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
      g. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. The following are specific types of instrumentation cables:
      a. Analog signal cable:
         1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
         2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.
      b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Wire connectors.
         2) Insulating tape.
         3) Cable lubricant.
      b. See Specification Section 16010 for additional requirements.
   3. Test reports:
      a. Fiber optic cable test reports per Specification 16080.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. Aetna Insulated Wire.
      b. Alphawire.
      c. Cerrowire.
      d. Encore Wire Corporation.
      e. General Cable.

f. Okonite Company.
g. Southwire Company.

2. Shielded VFD cable:
   a. Belden Inc.
   b. General Cable.
   c. Okonite Company.
   d. Olfex Wire and Cable, Inc.
   e. Priority Wire and Cable (Prysmian).
   f. Rockbestos-Surprenant Cable Corp.
   g. Southwire Company.

3. Instrumentation cable:
   a. Analog cable:
      1) Alphawire.
      2) Belden Inc.
      3) General Cable.

4. Wire connectors:
   a. Burndy Corporation.
   b. Buchanan.
   c. Ideal.
   d. Ilsco.
   e. 3M Co.
   f. Teledyne Penn Union.
   g. Thomas and Betts.
   h. Phoenix Contact.

5. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Building Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. When direct buried, UL listed and marked as suitable for direct bury.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
6. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.
7. Conductors No. 1/0 and larger used in a cable tray shall have a UL CT rating and conform to IEEE 1202 or CSA FT-4.

B. Power Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, including a bare ground conductor.
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.

b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC.

C. Control Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
5. Individual conductor color coding:
a. ICEA S-58-679, Method 1, Table E-2.
b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Shielded VFD Cable:
1. Conductor shall be copper, stranded with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Cables No. 00 through 750 kcmil:
a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
b. Shielding: 5 mil copper tape, longitudinally applied with a minimum overlap of 15 percent.
c. Number of conductors: 3 PH and 3 equally spaced ground conductors.
4. Individual conductor color coding:
a. ICEA S-58-679, Method 4.
b. See PART 3 of this Specification Section for additional requirements.
5. When installed exposed outdoors, UL listed and marked as sunlight resistant.
6. For continuously corrugated cable, use manufacturer approved fittings.
7. Conform to NFPA 70, Type TC.

F. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
a. Tinned copper conductors.
b. 300 V or 600 V PVC insulation with PVC jacket.
c. Twisted with 100 percent foil shield coverage with drain wire.
d. Four (4) twists per foot minimum.
e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
3. Digital cable:
a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
b. Horizontal voice and data cable:
1) Category 6 per TIA/EIA/ANSI 568.

2) Cable shall be label-verified.
3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4) Conductors: No. 24 AWG solid untinned copper.
5) Rated CMP per NFPA 70.

c. Conform to NFPA 262 and NFPA 70 Type ITC.

G. Fiber Optic Cable:
1. Design and fabrication - Multi-mode:
a. Type:
1) Outdoor: Loose tube with a wet or dry gel water blocking system.
b. Number of fibers: As indicated on the Drawings.
c. Fiber size: 62.5/125 micrometer (core diameter/cladding diameter).
d. Glass fiber core.
e. Step index.
f. Maximum attenuation:
1) At 850 nm: 3.75 dB/km.
2) At 1300 nm: 1.5dB/km.
g. Minimum bandwidth:
1) At 850 nm: 160 MHz/km.
2) At 1300 nm: 500 MHz/km.
h. Maximum tensile load:
1) Installation: 225 LBS.
2) Long term: 67 LBS.
i. Cable jacket material:
1) PVC, or polyethylene.
j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.
k. Optical fiber cable type utilized shall be in accordance with NFPA 70.
l. Utilize LC type connectors:
1) Tip material: Ceramic or ceramic/glass composite.
2) Utilize connectors which do not require adhesive, epoxy, or polish.

H. Wire Connectors:
1. Twist/screw on type:
a. Insulated pressure or spring type solderless connector.
b. 600 V rated.
c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
a. 600 V rated.
b. Ground conductors: Conform to UL 467.
c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.
c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.

I. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.

6. Color:
   a. Insulating tape: Black.
   b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

J. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:
   1. Type XHHW-2:
      a. Building wire and power and control cable in architectural and non-architectural finished areas.
      b. Building wire and power and control cable in conduit below grade.
   2. Type THHN/THWN and THHN/THWN-2:
      a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.
   3. Type SIS and MTW:
      a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Shielded VFD Cable:
   1. For wiring between a VFD and motor when routing in cable trays or conduit other than RGS or RAC.

C. Conductor Size Limitations:
   1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
   2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
   3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:
   1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

      a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
      b. Conductors larger than No. 6 AWG:
         1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:
            a) Continuous colored outer finish along its entire length.
            b) 3 IN of colored tape applied at the termination.

2) Insulated grounding conductor shall be identified by one (1) of the following methods:
a) Continuous green outer finish along its entire length.
b) Stripping the insulation from the entire exposed length.
c) Using green tape to cover the entire exposed length.
3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Bare.

3. Shielded VFD cable ICEA S-58-679, Method 4 with:
a. Phase conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Green color insulation or bare.

4. Control cables ICEA S-58-679, Method 1, Table E-2:
a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.
2. Where field conditions dictate and written permission is obtained from the Engineer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
a. The combinations shall comply with the following:
1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
2) 125 Vdc shall be isolated from all other AC and DC circuits.
3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
a. The combinations shall comply with the following:
1) Analog signal circuits may be combined.
2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.
a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
2) The neutral conductors may not be shared.
3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one (1) end only.
1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.
      c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
   4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Provide electrical equipment enclosure and cable sealing bushing when exposed conductors or cables enter the enclosure from cable trays.

J. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

K. Color Coding Tape Usage: For color coding of conductors.

L. Fiber Optic Cable:
   1. Unless indicated otherwise, install all fiber optic cable in conduit.
      a. In cable trays, the cable(s) shall be installed in an interduct that is placed in the tray for protection of the cable.
   2. Splicing:
      a. Optical fibers shall not be spliced.
   3. Utilize dust tight wall-mounted interconnect center to provide the following:
      a. Interconnect fiber optic cable to jumper cable assemblies for connection to the opto-electronic interface.
   4. Where exposed to contact with electric light or power conductors, the noncurrent carrying metallic members (if applicable) of optical fiber cables entering buildings shall be grounded as close to the point of entrance as practicable in accordance with NFPA 70.
   5. Install cables in accordance with the requirements of NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 16080.

END OF SECTION

1

2014/08/28

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16120 - Wire and Cable - 600 Volt and Below.
   5. Section 16135 - Electrical: Exterior Underground.
   6. Section 16140 - Wiring Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. ASTM International (ASTM):
      a. F512, Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      c. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
      d. TC 6&8, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations.
   4. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.5, Electrical Aluminum Rigid Conduit.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      c. 360, Standard for Liquid-Tight Flexible Steel Conduit.
      d. 467, Grounding and Bonding Equipment.
      e. 514B, Conduit, Tubing, and Cable Fittings.
      f. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
      g. 651A, Type EB and A Rigid PVC Conduit and HDPE Conduit.
      h. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Conduit fittings.
         2) Support systems.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid metallic conduits:
      a. Allied Tube and Conduit Corporation.
      b. Triangle PWC Inc.
      c. Western Tube and Conduit Corporation.
      d. Wheatland Tube Company.
      e. LTV Steel Company.
      f. EASCO Aluminum.
      g. Indalex.
      h. VAW of American, Inc.
   2. Rigid nonmetallic conduit:
      a. Carlon.
      b. Cantex.
      c. Osburn Associates.
   3. Flexible conduit:
      a. AFC Cable Systems.
      b. Anamet, Inc.
      c. Electri-Flex.
      d. Flexible Metal Hose Company.
      e. International Metal Hose Company.
      f. Triangle PWC Inc.
      g. LTV Steel Company.
   4. Wireway:
      a. Hoffman Engineering Company.
      b. Wiegmann.
      c. Square D.
   5. Conduit fittings and accessories:
      a. Appleton Electric Co.
      b. Carlon.
      c. Cantex.
      d. Crouse-Hinds.
      e. Killark.
      f. Osburn Associates.

g. OZ Gedney Company.
h. RACO.
i. Steel City.
j. Thomas & Betts.

6. Support systems:
   a. Unistrut Building Systems.
   b. Eaton B-Line.
   c. Kindorf.
   d. Minerallac Fastening Systems.
   e. Caddy.
   f. Thomas & Betts Superstrut.
7. Outlet, pull and junction boxes:
   a. Appleton Electric Co.
   b. Eaton Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
   e. Thomas & Betts Steel City.
   f. Raco.
   g. Bell.
   h. Hoffman Engineering Co.
   i. Wiegmann.
   j. Eaton B-Line.
   k. Adalet.
   l. Rittal.
   m. Stahlin.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 RIGID METALLIC CONDUITS

A. Rigid Aluminum Conduit (RAC):
1. AA Type 6063 aluminum alloy, T-1 temper.
2. Maximum copper content of 0.10 percent.
3. Extruded, seamless.
4. Standards: NEMA/ANSI C80.5, UL 6.

2.3 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.

B. Type EB (PVC-EB):
1. Polyvinyl-chloride (PVC) plastic compound.
2. Rated for concrete encasement.
3. Suitable for use with 90 DegC wire.
4. Standards: ASTM F512, NEMA TC 6&8, UL 651A.

2.4 FLEXIBLE CONDUIT

A. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vapor tight.

4. Standard: UL 360.

2.5 WIREWAY

A. General:
   1. Suitable for lay-in conductors.
   2. Designed for continuous grounding.
   3. Covers:
      a. Hinged or removable in accessible areas.
      b. Non-removable when passing through partitions.
   4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
   5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
   1. 14 or 16 gage steel without knockouts.
   2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Raintight (NEMA 3R) Wiring Trough:
   1. 14 or 16 GA galvanized steel without knockouts.
   2. Cover: Non-gasketed and held in place by captive screws.

D. Watertight (NEMA 4X rated) Wireway:
   1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

E. Dusttight (NEMA 12 rated) Wireway:
   1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

2.6 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RAC:
   1. Locknuts:
      a. Threaded steel or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   2. Bushings:
      a. Threaded, insulated metallic.
      b. Grounding or non-grounding type.
   3. Hubs: Threaded, insulated and gasketed metallic for rain tight connection.
   4. Couplings:
      a. Threaded straight type: Same material and finish as the conduit with which they are used on.
      b. Threadless type: Gland compression or self-threading type, concrete tight.
   5. Conduit bodies (ells and tees):
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. Cover:
         1) Clip-on type with stainless steel screws.
         2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
   6. Expansion/deflection couplings:
      a. 3/4 IN nominal straight-line conduit movement in either direction.
      b. 30-degree nominal deflection from the normal in all directions.
      c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.

d. Internally or externally grounded.
e. Watertight, raintight and concrete tight.

7. Standards: UL 467, UL 514B, UL 886.

B. Fittings for Use with FLEX-LT:
1. Connector:
a. Straight or angle type.
b. Metal construction, insulated and gasketed.
c. Composed of locknut, grounding ferrule and gland compression nut.
d. Liquid tight.
2. Standards: UL 467, UL 514B.

C. Fittings for Use with Rigid Nonmetallic PVC Conduit:
1. Coupling, adapters and conduit bodies:
a. Same material, thickness, and construction as the conduits with which they are used.
b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

D. Weather and Corrosion Protection Tape:
1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

A. Cast Outlet Boxes:
1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
a. "FS" or "FD".
b. "Bell".
c. Single or multiple gang and tandem.
4. Standards: UL 514A.

B. See Specification Section 16140 for wiring devices, wallplates and coverplates.

2.9 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four (4) sides.
3. Flat cover fastened with screws.

B. NEMA 4 Rated:
1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.

5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
6. Cover with oil resistant gasket.

C. NEMA 4X Rated (metallic):
1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.

D. NEMA 12 Rated:
1. Body and cover:
a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
b. Type 5052 H-32 aluminum, unpainted.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.

E. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

F. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
1. Material requirements.
a. Stainless steel: AISI Type 316.
b. Aluminum: AA Type 6063-T6.

B. Single Conduit and Outlet Box Support Fasteners:
1. Material requirements:
a. Stainless steel.

2.11 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
1. See Specification Section 01800.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
1. NFPA 70.
2. Manufacturer instructions.

B. Size of Raceways:
1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.

2. Unless specifically indicated otherwise, the minimum raceway size shall be:
    a. Conduit: 3/4 IN.
    b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:
1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
1. See Specification Section 01800.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
    a. Through areas of high ambient temperature or radiant heat.
    b. In suspended concrete slabs.
4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:
1. As indicated on the Drawings.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 Vdc: 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between telecommunication and 600 V and less AC power or control: 6 IN.

5. Between process and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
   1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
   1. See Specification Section 01800.
   2. New construction:
      a. Sleeves and blockouts:
         1) Set in masonry walls during erection.
         2) Set in concrete walls and floors during forming.
      b. Sleeves not considered to structurally replace the displaced concrete.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
   1. Power wire or cables: All raceway types.
   2. Control wire or cables: All raceway types.
   3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
   4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
   5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
   1. Dry areas:
      a. RAC.
   2. Wet areas:
      a. RAC.

C. Permitted Raceway Types Per Routing Locations:
      a. NEMA 1 rated wireway.
   2. Embedded in poured concrete walls and floors:
      a. PVC-40.
   3. Through floor penetrations, see Specification Section 01800:
      a. RAC wrapped with field applied weather and corrosion protection tape when emerging from concrete into areas designated as dry, wet, corrosive or highly corrosive.
   4. Direct buried conduits and ductbanks:
      a. PVC-80.
   5. Concrete encased ductbanks:
      a. PVC-EB.
      b. 90 degree elbows for transitions to above grade:
         1) PVC-RAC.

D. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 1 FT to light fixtures.
      b. 3 FT to motors.
      c. 2 FT to all other equipment.

E. NEMA 1 Rated Wireway:
   1. Surface mounted in electrical rooms.

F. NEMA 4X Rated Wireway:
   1. Surface mounted in areas designated as wet and or corrosive.

G. NEMA 12 Rated Wireway:
   1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

H. Underground Conduit: See Specification Section 16135.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
   1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

B. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
   2. Elsewhere as identified on the Drawings.

C. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

D. Threaded connections shall be made wrench-tight.

E. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.
   3. Underground.

F. Terminate Conduits:
   1. In metallic outlet boxes:
      a. RAC}:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
   2. In NEMA 1 rated enclosures:
      a. RAC:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
   3. In NEMA 12 rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
      b. Use grounding type locknut or bushing when required by NFPA 70.
   4. In NEMA 4 and NEMA 4X rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
   5. When stubbed up through the floor into floor mount equipment:
      a. With an insulated grounding bushing on metallic conduits.
      b. With end bells on nonmetallic conduits.

G. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Dry or wet and/or hazardous areas:
      a. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.
   2. Conduit type shall be compatible with the support system material.
      a. Stainless steel system may be used with RAC.
      b. Aluminum system may be used with RAC.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Dry or wet areas:
      a. Material: stainless steel..
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   2. Conduit type shall be compatible with the support fastener material.
      a. Stainless steel system may be used with RAC.

C. Conduit Support General Requirements:
   1. Maximum spacing between conduit supports per NFPA 70.
   2. Support conduit from the building structure.
   3. Do not support conduit from process, gas, air or water piping; or from other conduits.
   4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
      a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
      b. Conduit hangers:
         1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
      c. Do not use suspended ceiling support systems to support raceways.
      d. Hangers in metal roof decks:
         1) Utilize fender washers.
         2) Not extend above top of ribs.
         3) Not interfere with vapor barrier, insulation, or roofing.
   5. Conduit support system fasteners:
      a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
      b. Do not use concrete nails and powder-driven fasteners.
      c. Comply with the requirements of Specification Section 05505 for fasteners in cast-in-place concrete construction.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. See Specification Section 16010 and the Drawings for area classifications.
   3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
   4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:
   1. Permitted uses of cast outlet boxes:
      a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
      b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.

2. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 16010.
3. Set device outlet boxes plumb and vertical to the floor.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 4, painted steel enclosure:
   a. Pull or junction box surface mounted in areas designated as wet.
3. Permitted uses of NEMA 4X, stainless steel metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
4. Permitted uses of NEMA 12, Aluminum enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

1

2014/08/28

SECTION 16132
CABLE TRAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cable tray and associated fittings and supports.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 16010 - Electrical: Basic Requirements.
   5. Section 16060 - Grounding.
   6. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. National Electrical Manufacturers Association (NEMA):
      a. VE-1, Metal Cable Tray Systems.
      b. VE-2, Metal Cable Tray Installation Guidelines.
   3. Underwriters Laboratories, Inc. (UL).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.3 DEFINITIONS

A. Types of Cable Tray:
   1. Ladder: A prefabricated metal structure consisting of two (2) longitudinal side rails connected by individual transverse members of rungs.
   2. Ventilated trough: A prefabricated metal structure consisting of two (2) longitudinal side rails and a ventilated bottom with clear openings no greater than 4 IN.
   3. Solid-bottom: A prefabricated metal structure consisting of two (2) longitudinal side rails and a bottom with no openings within the cable-bearing surface.
   4. Channel: A prefabricated metal structure consisting of a one-piece ventilated or solid bottom channel section not exceeding 6 IN in width.
   5. Single-rail: A prefabricated metal structure consisting of one (1) longitudinal rail with transversely connected rungs that project from one (1) or both sides, which may be single- or multi-tier.
   6. Wire-mesh: A rigid tray systems constructed from high strength wire spaced parallel with 2 IN longitudinal and 4 IN transverse wire, spot welded at all intersections.

1.4 SYSTEM DESCRIPTION

A. The following is a brief description of the types of the trays to be used.
   1. Collector Building.: Aluminum, ladder type tray.

B. Miscellaneous:
1. Cable tray systems are sized on the Drawings.
2. When cable tray system size is not shown on the Drawings or scheduled, the cable tray shall be sized in accordance with the NFPA 70 and the requirements of this Specification Section.
3. Cable tray runs, where shown, are diagrammatic and intended to be used as a guide, unless otherwise indicated on the Drawings.
a. Site conditions may affect actual routing.
b. Contractor shall coordinate routing and measurement with other trades and with equipment suppliers to avoid interference with equipment, piping, ductwork, etc.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
a. Provide submittal data for all products specified in PART 2 of this Specification Section.
b. See Specification Section 16010 for additional requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metallic cable tray systems:
a. Eaton B-Line.
b. T.J. Cope.
c. Husky/Burndy.
d. Thomas & Betts.
e. P-W Ind.
2. Cable tray conduit and ground clamps and brackets:
a. Eaton B-Line.
b. P-W Ind.
c. O.Z. Gedney.
d. Thomas & Betts.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 COMPONENTS

A. Ladder Tray:
1. Materials:
a. Aluminum:
1) Side channels: Heat treatable alloy Type 6063-T6.
2) Transverse elements: Heat-treated alloy Type 6063-T6 (solid channel) or Type 6063-NHT (tubular).
3) Hardware: Stainless steel.
2. Fabrication:
a. Standard:
1) Metallic: NEMA VE-1.
b. The working (allowable) load capacity: NEMA VE-1 designation A.

c. Side rails:
   1) I-beam or channel.
   2) Flange in or out (full width top opening).
   3) Useable clear nominal loading depth: 4 IN.
d. Transverse elements: Solid bar, tube, or channel with stiffened flanges.
e. Maximum centerline rung spacing on straight sections: 9 IN.
f. Metallic trays shall be UL classified per NFPA 70 as an equipment grounding conductor.

B. Fittings:
   1. Radius of bends: As required for cable layout in tray.
   2. Degrees of arc for elbows: As required for cable tray layout.

2.3 ACCESSORIES

A. Accessories including but not limited to, splice plates, barrier strips, drop outs, box connector, end plate and conduit clamps to be the same material as the tray or other compatible material.

B. Cable Tray Ground Clamps:
   1. Malleable iron or tin-plated extruded aluminum with stainless steel screws.
   2. Serrated edges to bite into and bond to the cable tray system.

C. Support system:
   1. Material: See Specification Section 16010 for material specifications.
   2. See PART 3 of this Specification Section for material type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with NEMA VE-2 and as recommended by the manufacturer's instructions unless otherwise indicated on the Drawings.

B. Install cable tray, fittings and accessories, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.

C. Install cable tray systems as close as practical to the locations and elevations shown on the Drawings.
   1. Minor changes (12 IN or less) in location or elevation may be made to avoid interference with piping, ductwork and equipment.
   2. Obtain Engineer's approval prior to making major changes (greater than 12 IN) in location or elevation.
   3. When cable tray is located adjacent to, beneath or near large piping or major equipment, or terminates at equipment; do not install cable tray until the installation of such piping and equipment is complete.
   4. Insure openings are provided in walls that cable tray will penetrate.

D. Cable Tray Supports:
   1. Provide supports at required locations to provide the loading capacity per the Contractors fill calculations.
   2. Cantilever bracket type when cable tray is installed adjacent to a wall.
   3. Trapeze type hangers for all other applications.
   4. For vertical runs in excess of 20 FT support the tray by angles bolted through the side rails and suspended from hanger rod, which is connected to a cantilevered support.
   5. In seismic locations provide required supports and/or sway bracing per local Building Codes.

E. Permitted prefabricated bracket or trapeze type support system per area designations and tray material:
   1. Dry or wet areas:
      a. Aluminum system consisting of: Aluminum channels and fittings with stainless steel nuts and hardware and conduit clamps.
   2. Tray material shall be compatible with the support system material.
      a. Stainless steel system may be used with zinc coated, stainless steel, aluminum and nonmetallic trays.
      b. Aluminum system may be used with aluminum trays.

F. Maintain electrical continuity of the cable tray system.
   1. Bolt connectors to each section or fitting.
   2. Span expansion connectors by a bonding jumper.
   3. Use one (1) of the following to bond conduits to the tray:
      a. Conduits connected to the cable tray system by a one-piece conduit clamp shall be considered bonded to the cable tray system.
      b. Terminate conduits connected to the cable tray system by a bracket and clamp assembly in an insulated grounding bushing and bond to the cable tray system.
   4. Tighten all bolted connections to manufacturer's recommendations to ensure electrical continuity.

G. Cable Tray System Grounding: See Specification Section 16060.

H. Conduit terminating at a cable tray system: See Specification Section 16130.

I. Use flanged fittings to terminate cable tray systems at switchgear, motor control centers, and other equipment, unless indicated otherwise on the Drawings.

J. Install barrier strips in cable tray systems containing both power and control wiring to physically separate the control cables from the power cables.

K. Cable Installation:
   1. Conductors #4/0 AWG and less, shall be in a multi-conductor cable.
   2. Conductors 250 kcmil and larger, shall be single conductor cables bundled together, Phase A, B, C and neutral and/or ground when required.

3.2 FIELD QUALITY CONTROL

A. Tray Fill Calculations:
   1. Cable tray fill shall not exceed NFPA 70 requirements.
   2. Additional cables will need to be installed in the cable trays by Division 13 (e.g., process control digital communication, security, fire alarm, HVAC).

B. Remove trash and accumulated dirt from the entire cable tray system at the completion of the project and install covers where applicable.

C. Tagging and Warning Signs: See Specification Section 10400.

END OF SECTION

2014/08/28

SECTION 16135
ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 02221 - Trenching, Backfilling and Compacting for Utilities.
   4. Division 03 - Concrete.
   5. Section 10400 - Identification Devices.
   6. Section 16060 - Grounding.
   7. Section 16130 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Direct-buried conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout Drawings:
      a. Provide dimensional Drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
   2. Precast manholes.:
      a. Utility Vault Co.
      b. Oldcastle Precast, Inc.
      c. Lister Industries.
   3. Manhole and handhole and ductbank accessories:
      a. Neenah.
      b. Unistrut.
      c. Condux International, Inc.
      d. Underground Devices, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   2. Minimum load ratings: SCTE 77 Tier 15.
   3. Open bottom.
   4. Stackable design as required for specified depth.
   5. Cover:
      a. Engraved legend of "FIBER OPTIC".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Gasketed bolt down with stainless steel penta head bolts.
      d. Lay-in non-bolt down, when cover is over 100 LBS.
      e. One or multiple sections so the maximum weight of a section is 125 LBS.
   6. Cover lifting hook: 24 IN minimum in length.

B. Precast Manholes:
   1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
   2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
   3. Mating edges: Tongue and groove type.
   4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
   5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
   6. Cover extension rings as required.
   7. Cable pulling eyes opposite all conduit entrances.
      a. Coordinate exact location with installation contractor.

2.3 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

A. Cover and Frame:
   1. Cast ductile iron: ASTM A536.
   2. AASHTO live load rating: H-20.
   3. Diameter: 30 IN.
   4. Cast the legend "ELECTRICAL" or "FIBER OPTIC" into manholeand handhole covers.
      a. Stainless steel penta-head bolts.

B. Cable Racks and Hooks:
   1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
   2. Hook loading capacity: 400 LBS minimum.
   3. Rack loading capacity: Four (4) hooks maximum.
   4. Hook deflection: 0.25 IN maximum.
   5. Hooks: Length, as required, with positive locking device to prevent upward movement.
   6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
   1. 7/8 IN DIA hot-dipped galvanized steel.
   2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 16060.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03.

B. Duct Terminators:
   1. Designed for installation into manhole walls for a watertight seal.

C. Conduit: See Specification Section 16130.

D. Duct Spacers/Supports:
   1. High density polyethylene or high impact polystyrene.
   2. Interlocking.
   3. Provide 2 IN minimum spacing between conduits.
   4. Accessories, as required:
      a. Hold down bars.
      b. Ductbank strapping.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks.
   1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in ductbank routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
   7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 02221 for trenching, backfilling and compacting.

3.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. For use in areas subjected to occasional non-deliberate vehicular traffic.

2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes:
1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
a. Grout or seal all joints, per manufacturer's instructions.
b. Support cables on walls by cable racks:
1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes.
a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
c. In each manhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
1) Drill opening in floor for ground rod.
2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
3) Utilize a ground bar in the manhole if the quantity of ground wires exceeds three (3).
a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
3. Place manhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.
a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes.
6. Handhole size:
a. Eighteen inches by thirty six inches or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 1.5 FT x 3 FT and minimum depth of 2 FT.
7. Manhole size:
a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
1. Ductbank types per location:
a. Concrete encased ductbank:
1) Power and data duct bank from multi-terminal cabinet to the collector well.
2) Power and data duct bank from the generator to the support wall of the electrical distribution gear.
3) As indicated in the Drawings.
2. Do not place concrete or soil until conduits have been observed by the Engineer.
3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
a. Low points shall be at manholes.
4. During construction and after conduit installation is complete, plug the ends of all conduits.

5. Provide conduit supports and spacers.
    a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
        1) 3-1/2 to 6 IN: 7 FT.
    b. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
6. Stagger conduit joints at intervals of 6 IN vertically.
7. Make conduit joints watertight and in accordance with manufacturer's recommendations.
8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
    a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
9. Furnish manufactured bends at end of runs.
    a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.
10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
11. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 16130, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10400.
15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:
1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 16130 or as detailed on the Drawings.
2. Install so that top of concrete encased duct, at any point:
    a. Is not less than 36 IN below grade.
    b. Is below pavement sub-grading.
3. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.
4. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 16130 for different cabling types.

C. Direct-Buried Conduit(s):
1. Install so that the top of the uppermost conduit, at any point:
    a. Is not less than 36 IN below grade.
    b. Is below pavement sub-grading.

2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 16130 for different cabling types.
    a. Maintain the separation of multiple planes of conduits by one of the following methods:
        1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 psi) or concrete per Specification Section 02221.
        2) Install the multilevel conduits one level at a time.
            a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 02221, to maintain the required separations.

END OF SECTION

2014/08/28

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Light switches.
      b. Receptacles.
      c. Device wallplates and coverplates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16130 - Raceways and Boxes.
   5. Section 16442 - Motor Control Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 943, Ground-Fault Circuit-Interrupters.
      d. 1449, Standard for Surge Protective Devices.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Light switches and receptacles:
      a. Bryant.
      b. Eaton Cooper Wiring Devices.
      c. Hubbell.
      d. Leviton.
      e. Pass & Seymour.
      f. Eaton Crouse-Hinds.

g. Appleton Electric Co.
h. Killark.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 LIGHT SWITCHES

A. General requirements unless modified in specific requirements paragraph of switches per designated areas or types:
1. Toggle type, quiet action, Industrial Specification Grade.
2. Self grounding with grounding terminal.
3. Back and side wired.
4. Solid silver cadmium oxide contacts.
5. Rugged urea housing and one-piece switch arm.
6. Rated 20 A, 120/277 Vac.
7. Switch handle color: Black.
8. Types as indicated on the Drawings:
a. Single-pole.
b. 3-way.
c. 4-way.
9. Standards: UL 20, UL 514A, NEMA WD 6.

B. Dry Non-architecturally Finished Areas:
1. Coverplate:
a. Zinc plated malleable iron or galvanized steel.
b. Single or multiple gang as required.

C. Wet Non-architecturally Finished Areas:
1. Coverplate:
a. Gasketed zinc plated malleable iron or aluminum with stainless steel screws utilizing rocker, front mounted toggle or pull type switch.
b. Single or multiple gang as required.

D. Door Switches:
1. Pressure sensitive switch, complete with galvanized box and cover and wire leads.
2. Rated 5 A, 120 Vac.

2.3 RECEPTACLES

A. General requirements unless modified in specific requirements paragraph of receptacles per designated areas:
1. Straight blade, Industrial Specification Grade.
2. Brass triple wipe line contacts.
3. One-piece grounding system with double wipe brass grounding contacts and self grounding strap.
4. Back and side wired.
5. Rated 20 A, 125 Vac.
6. High impact nylon body.
7. Receptacle body color:
a. Normal power: Black.
8. Types as indicated on the Drawings:
a. Normal: Self grounding with grounding terminal.
b. Ground fault circuit interrupter: Feed-through type with test and reset buttons.
9. Duplex or simplex as indicated on the Drawings.
10. Configuration: NEMA 5-20R.
11. Standards: UL 498, UL 514A, UL 943, NEMA WD 1, NEMA WD 6.

B. Dry Non-Architecturally Finished Areas:
1. Coverplate:
a. Zinc plated malleable iron or galvanized steel.

b. Single or multiple gang as required.

C. Exterior Locations:
1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, flame retardant, UV stabilized polycarbonate, 2.5 IN minimum cover depth.
2. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.
3. Coverplate: Weather resistant zinc plated or aluminum, gasketed, self-closing cover using stainless steel spring.

2.4 MISCELLANEOUS WIRING DEVICES

A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 16442.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 16010.

C. See Specification Section 16130 for device outlet box requirements.

D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

END OF SECTION

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2014/10/07

SECTION 16230
ENGINE GENERATOR: DIESEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Engine generator set and accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 15 - Mechanical.
   4. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Environmental Protection Agency (EPA):
      a. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   3. National Fire Protection association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 700, Emergency Systems.
   4. Underwriters Laboratories, Inc. (UL):
      a. 2200, Standard for Stationary Engine Generator Assemblies.

B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and installation of the unit.

1.3 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:
   1. Legally required standby power during a utility power outage, NFPA 70, Article 701.
   2. Generator shall be sized to start and power two (2) 200 HP, VFD driven water pumps and associated electrical equipment as shown in the drawing set. Estimated size of 500 KW to be confirmed by vendor.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
      c. Engine/generator performance curves.
   3. Fabrication and/or layout Drawings.
      a. Dimensional plan and elevation Drawings.
      b. Wire interconnection Drawings.

4. Test reports:
    a. Factory test reports.

B. Operation and Maintenance Manuals:
    1. See Specification Section 01342 for requirements for:
        a. The mechanics and administration of the submittal process.
        b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
    1. Unit installation, startup and operational statement.
    2. Field Quality Control test reports.

1.5 SITE CONDITIONS

A. Ambient air temperature:
    1. Minimum: -20 DegF.
    2. Maximum: 105 DegF.

B. Altitude: 1150 FT above sea level.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Engine generator unit:
        a. Caterpillar.
        b. Cummins Onan.
        c. Kohler.
        d. Generac.
        e. Waukesha.
        f. Detroit Diesel.
    2. Silencers:
        a. Maxim.
        b. GT Exhaust Systems.
        c. Nelson.
        d. Cowl.
        e. Hapco.
    3. Battery charger:
        a. Manufacturer's standard.
    4. Governor:
        a. Manufacturer's standard.
    5. Radiator:
        a. Manufacturer's standard.
    6. Vibration isolators:
        a. Caldyne.
        b. Mason Inds.
        c. Ace.
        d. Korfund Dynamics.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 EQUIPMENT

A. Emissions Requirements:
   1. A single units emissions shall meet all Federal, State and Local government requirements, including but not limited too:
      a. Environmental Protection Agencies (EPA) New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart IIII.

2.3 COMPONENTS

A. Engine Generator Unit General:
   1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.
   2. Mount unit on skid suitable for installation on concrete foundation.
   3. Base rating on operation at rated RPM when equipped with all operating accessories.
   4. Standards: UL 2200.

B. Engine:
   1. Four-cycle, full compression ignition, single acting, solid-injection unit, either vertical or V-type pistons turbo charged with after cooling.
   2. Fuel supply: No. 2 Diesel.
   3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
   4. Capable of operating at idle or light loads for extended periods of time.

C. Injection Pumps and Valves:
   1. Type not requiring adjustment in service, which may be individually removed and replaced.
   2. Individual injection pump and valve for each cylinder.
   3. Fuel injection pumps: Positive action, constant-stroke, actuated by cam driven by gears from engine crankshaft.
   4. Fuel lines between injection pumps and valves: Heavy seamless steel tubing.
   5. Flexible fuel line connectors for supply and return connections at pump.

D. Oil Pump:
   1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
   2. Spray cool and lubricate pistons.
   3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
   4. Filter elements accessible and easily removable.
   5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
   6. Equip filter system with spring-loaded by-pass valve.
   7. Oil cooler: Water-cooled, engine-mounted.

E. Fuel System:
   1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump.
   2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
   3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
   4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.

F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 percent of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.

G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

H. Electric Starting System:
1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
2. Controls to provide automatic cranking of engine when generator is called to start.
3. Prevent excessive cranking which could damage cranking motor.
4. Automatic stop controls.
5. Starter motors with positive-engagement feature.

I. Cooling System:
1. Capacity for cooling engine at the specified operating conditions.
2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
3. Unit mounted radiator.
   a. Core guard flexible duct adapter.
   b. Site glass at top of unit.
   c. Engine driven blower fan.
   d. Low water level cutoff switch.
4. Provide fan guards.

J. Heater:
1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
   a. 240V, single phase.
2. Lube oil heater, 120V, 300W.
3. Battery pad heaters, 120V.

K. Silencer:
1. Suitable type for industrial silencing.
2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.

L. Engine Instruments and Controls:
1. Engine-mounted instruments:
   a. Oil pressure gage.
   b. Water temperature gage.
   c. Run time meter.
   d. Battery voltage meter.
2. Automatic cycle cranking and over-crank protection.
3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.
5. Three (3) NO auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.
   a. Contacts shall close when generator is started.

M. Fuel Day Tank:
1. Double wall sub-base day tank mounted underneath engine generator unit.
2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.
3. Tank connections: Fuel level gauge, fuel lines to generator, fill, vent, drain and pressure relief.
4. Manual overfill protection.
5. Low level warning with contacts for remote alarm.
   a. Set to alarm at 50 percent of capacity.
6. Critical low level shutoff with contacts for remote alarm.
7. Leak detection alarm with contacts for remote alarm.

8. Capacity: Fuel for approximately 16 HRS of run time at full load.

N. Batteries:
1. Lead acid type.
2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.
3. Thermostatically controlled 120Vac battery pad heater.

O. Battery Charger:
1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 Vac input.
3. Malfunction alarm contacts (minimum): Low and high battery voltage, weak battery and charger failure.

P. Generator:
1. Brushless, 6-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
2. Minimum continuous standby ratings:
   a. As indicated on the Drawings, substantiated by manufacturer's standard published curves and conform to NEMA MG 1 specification.
   b. Special ratings or maximum ratings are not acceptable.
3. Rated to serve up to 50 percent non-linear load without exceeding rated temperature rise.
4. Minimum efficiency: 92 percent at 50 to 110 percent of nominal standby rating, less than 30 percent instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other future units connected in parallel.
5. Stator and rotor: 125 DegC temperature rise with minimum Class F insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
6. Directly connect stator to engine flywheel housing.
7. Drive rotor through semi-flexible driving flange to ensure permanent alignment.
8. Self ventilating with suitable blower, air inlet and outlet openings.
9. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
10. Generator drive free from critical torsional vibration within operating range.
11. Provide generator mounted main circuit breaker:
   a. Solid state molded case type with LSI trip unit.
   b. Ratings as supplied by the generator manufacturer.

Q. Voltage Regulator:
1. SCR type, to maintain 2 percent voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 percent including cross-current compensation to provide maximum of 5 percent unbalance in kVA load sharing between this unit and possible future generators.
2. Automatic protection against short circuits on system.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of plus or minus 5 percent from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

R. Generator Instruments and Controls:
1. Generator mounted NEMA 1 type, illuminated vibration isolated instrument and control panel(s).
2. AC voltmeter and phase selector switch.
3. AC ammeter and phase selector switch.
4. Frequency meter.
5. Run-off-auto engine, start-stop control switch.

6. Emergency stop.
7. Run time meter.
8. Governor control rheostat.
9. Voltage level adjustment rheostat.
10. Cool down time delay 0-15 minute adjustable.
11. Cycle cranking control.
12. Minimum red shut down indicating lights as follows:
    a. Overcrank.
    b. Overspeed.
    c. Low lubricating oil pressure.
    d. High engine water temperature.
13. Minimum amber alarm indicator lights as follows:
    a. Control switch not in auto position.
    b. Low engine water temperature (less than 70 DegF).
    c. Low fuel in day tank.
    d. Day tank leak.
    e. Battery charger malfunctioning.
    f. Low battery voltage.
14. Minimum amber pre-alarm indicator lights as follows:
    a. High engine water temperature.
    b. Low lubricating oil pressure.
15. Common dry contact and audible alarm to indicate when one (1) or more alarm or pre-alarm conditions exist.

S. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

2.4 ACCESSORIES

A. Provide interposing relays (24 Vdc to 120 Vac) as required for interfacing with customer's 120 Vac monitoring system.

B. Generator remote annunciator panel:
1. Surface mounted NEMA 1 enclosure capable of dedicated network communication with generator control system at a distance of 2,000 FT minimum.
2. Circuits:
    a. 24 Vdc.
3. Provide red and green signal lamps, buzzer, silencing switch, lamp test switch, relays, solid-state components, and engraved function identifications.
4. Annunciator functions:
    a. Green light "ON" to indicate generator is operating to supply power to load.
    b. Separate red light for each shutdown or alarm condition and amber light for each prealarm condition and common buzzer with silence/ acknowledge switch.
    c. Shut down indicating lights as follows:
        1) Overcrank.
        2) Overspeed.
        3) Low lubricating oil pressure.
        4) High engine water temperature.
    d. Alarm indicator lights as follows:
        1) Control switch not in auto position.
        2) Low engine water temperature (less than 70 DegF).
        3) Low fuel in day tank.
        4) Fuel in day tank rupture basin.
        5) Battery charger malfunctioning.
        6) Low battery voltage.

e. Pre-alarm indicator lights as follows:
1) High engine water temperature.
2) Low lubricating oil pressure.

C. Manual stop break glass station: Shuts down generator from remote rack next to remote IO panel at utility power incoming location.

D. Generator set non-walk-in weather protective enclosure:
1. Sheet steel with side servicing panels, air intake louvers and rear control panel access door.
2. Side servicing panels shall have two (2) locking points; all panels and doors are key lockable.
3. Pitched roof with silencing exhaust muffler mounted inside the enclosure.
4. Completely install enclosure on generator set mounting base.

2.5 SOURCE QUALITY CONTROL

A. Individually test each prime mover.
1. Apply derating factors for the proposed site to test data.
2. Continuously test for a period no less than 2 HRS.
3. Test procedure shall be as follows:
a. Start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating at rated power factor in one (1) step.
b. Observe and record the cranking time(s) required to start and run for each prime mover.
c. Observe and record the time required to come up to operating speed for each prime mover.
d. Record voltage and frequency overshoot for each prime mover.
e. Record voltage, frequency and amperes.
f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

2.6 MAINTENANCE MATERIALS

A. Spare Parts: Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DegF.

C. Provide fuel for a full day tank.

D. Install all wiring to engine in conduit.
1. Control wiring on engine may be factory installed in high temperature loom.

E. Provide control wiring in conduit between generator control panel, remote annunciator panel and remote devices as described under generator instrument and controls paragraph and remote annunciator paragraph of this Specification.

F. Mount on concrete pad utilizing vibration/seismic isolators, see structural drawings for pad detail.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by this Specification Section.

2. Supervise pre-startup adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks.
4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
5. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.

B. Provide two (2) load tests and one (1) cycle crank test.
1. Tests one (1) and two (2) shall be for continuous period of no less than 2 HRS each.
2. Engineer and Owner shall be notified seven (7) days prior to testing.
3. Test number one:
a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
b. Observe and record the time delay on engine start.
c. Observe and record the cranking time(s) required to start and run for each prime mover.
d. Observe and record the time required to come up to operating speed for each prime mover.
e. Record voltage and frequency overshoot for each prime mover.
f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.
g. Record voltage, frequency and amperes.
h. Record oil pressure, water temperature where applicable and battery charge rate at 5-minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.
i. Return normal power to facility, record time delay on retransfer to normal for each switch and cool down time delay for each prime mover.
4. Test number two:
a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating in one (1) step.
1) Unity power factor is acceptable for on-site testing.
b. Observe and record the cranking time(s) required to start and run for each prime mover.
c. Observe and record the time required to come up to operating speed for each prime mover.
d. Record voltage and frequency overshoot for each prime mover.
e. Observe and record time required to achieve steady-state condition.
f. Record voltage, frequency and amperes.
g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.
5. Cycle crank test:
a. Perform test for each prime mover.
1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.
2) Put control switch into "run" position to cause prime mover to crank.
b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.
1) Upon starting and running of the prime mover, further cranking shall cease.
2) Two (2) means of cranking termination shall be utilized so that one (1) will act as a backup to the other to prevent inadvertent starter engagement.
3) Cranking limiter time shall be 75 seconds for cycle crank.
6. Furnish load banks of required ratings necessary for tests.
7. Record engine fuel consumption by means of test equipment.

8. Test all safeties specified for generator instruments and controls and generator remote annunciator panel as recommended by manufacturer and as required to verify proper operation.
9. Contractor shall be responsible for fuel and all consumables use during the test.

END OF SECTION

1

2014/10/07

SECTION 16265
VARIABLE FREQUENCY DRIVES: LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Variable frequency drives (VFDs) for operation of inverter duty motors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.
   4. Section 11005 - Equipment: Basic Requirements.
   5. Section 13441 - Control Loop Descriptions.
   6. Division 15 - Mechanical.
   7. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
      b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   4. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors Motor Circuits, and Controllers..
   6. Occupational Safety and Health Administration (OSHA).
   7. Underwriters Laboratory, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.

B. Qualifications:
   1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
   2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
   3. VFD Supplier shall maintain an authorized service organization within 300 miles of the Project Site.

C. Coordination:
1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
2. Motor and VFD coordination: See Specification Section 11005.
3. VFD shall be supplied complete with all required control components.
a. Provide control as indicated:
1) On the Electrical Drawings.
2) As specified in this Specification Section.
3) As specified in the process control system loop descriptions.
a) See Specification Section 13441.
b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.
4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

1.3 DEFINITIONS

A. Variable Torque (VT):
1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

C. Low Voltage: 600 Vac or less.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Provide a schedule for each VFD including the following information:
a. Equipment Tag Number.
b. VFD Complete Catalog Number.
c. VFD Amp Frame Size.
d. Variable or Constant Torque Rating Basis.
e. Rated Input Current.
f. Rated Continuous Output Current.
g. Rated Short Circuit Current.
h. VFD cable type specified (shielded or non-shielded).
i. VFD Maximum Motor Lead Length for the type of cable used.
j. Motor Manufacturer.
k. Motor Frame Size.
l. Motor Full Load Amps.
m. Motor Service Factor.
n. As installed motor Lead Length.
o. VFD options provided to meet harmonic or motor protection specifications.

3. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
4. Product technical data:
    a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
    b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
    c. Manufacturer's installation instructions.
    d. Manufacturer's programming and operating instructions.
    e. See Specification Section 16010 for additional requirements.
5. Fabrication and/or layout Drawings:
    a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
    b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
    c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
    d. Interior layout Drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
    e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
6. Certifications:
    a. Submit with Shop Drawings:
        1) Identification and location of closest authorized service organization.
        2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
    b. Submit prior to shipment:
        1) Certified factory test reports confirming compliance with specified requirements.
    c. Submit after installation:
        1) Certified field service reports showing:
            a) Each VFD is operational.
            b) Each VFD and its driven equipment motor are compatible.
            c) Each VFD responds correctly to the input control signals.
            d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
            e) Measured harmonic levels per Harmonic Protection Requirements Article.
            f) Measured motor terminal peak voltages per Motor Protection Requirements Article.

B. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. Approved copy of VFD schedule per Submittals Article.
3. Manufacturer's instruction manuals.
4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
6. Recommended spare parts list.
7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen Bradley.
   2. ASEA Brown Bovari (ABB).
   3. Eaton.
   4. Danfoss.
   5. General Electric Company.
   6. Siemens.
   7. Square D Company.
   8. Toshiba.
   9. Yaskawa.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
   1. Motor control.
   2. Motor overload protection.
   3. Motor and motor branch circuit short circuit and ground fault protection.
   4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an “engineered” or “configured” drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:
   1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 percent of base speed of the driven equipment.
   2. VFDs shall be compatible with:
      a. Inverter duty induction motors.
   3. VFDs shall be suitable for Variable Torque (VT) applications.
      a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify application.
   4. VFDs shall be designed to operate successfully under the following site conditions:
      a. Ambient:
         1) Temperature: 0-40 DegC.
         2) 95 percent non-condensing relative humidity.
      b. Elevation: 950 FT above MSL.
      c. Power supply characteristics:
         1) 480Vac, 3 PH, 60 Hz, 3 wire, (+/- 10 percent).
         2) Effectively grounded.

B. Ratings and Performance Specifications:
   1. Voltage rating:
      a. Nominal: 480Vac, 3 PH, 60 Hz.
      b. Range for continuous full load operation: ±10 percent of nominal.
      c. Voltage imbalance tolerance for full load operation: 3 percent minimum.
   2. Current ratings:
      a. Continuous:
         1) Equal to or greater than the motor nameplate full load.
      b. Short-term overload:
         1) VT: 110 percent for 1 minute.
         2) Permissible for 1 minute every 10 minutes continuously.
      c. Short circuit:
         1) 42,000A RMS SYM, minimum.
         2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
         3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.
   3. Efficiency:
      a. 97 percent, minimum, at full speed and full load.
      b. 93 percent, minimum at 1/2 speed and full load.
   4. Displacement power factor:
      a. 95 percent, minimum from 50 percent to 100 percent speed and load.
   5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
   6. Frequency drift:
      a. +0.5 percent of set frequency.
   7. Speed regulation (motor dependent): 3 percent.
   8. Speed range: 10:1.
   9. Control type:
      a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
         1) When operating under voltage boost.
         2) At frequencies over 60 Hz.

C. Operational Features:
   1. Insensitive to input phase sequence.
   2. Continued operation with momentary voltage dips of 25 percent of rated voltage, or single phase condition: 4 second, minimum.
   3. Controls power loss ride-through: 500 msec, minimum.
   4. Electronic reversing.
   5. DC injection braking.
   6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
   7. Critical frequency band lockout:
      a. Minimum of three (3) settings.
      b. Adjustable bandwidth, 1 - 5 Hz.
   8. Capable of operating without the motor connected for start-up and troubleshooting.

D. The VFD shall be provided with the following minimum user-programmable parameters:
   1. Carrier frequency.
   2. Independent maximum and minimum speeds for forward and reverse operation.
   3. Start frequency and hold time.
   4. Independent linear acceleration and deceleration time.
   5. Preset “jog” speed.
   6. Three (3) critical frequency bands.
   7. One (1) preset speed selectable by logic input.

8. Volts/Hertz ratio.
9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.
14. Ground fault pickup.
15. DC injection level and time.

E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
   1. General:
      a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
         1) Input under voltage.
         2) Input over voltage.
         3) Input under frequency.
         4) Input over frequency.
         5) Input Phase loss.
         6) DC Bus under voltage.
      b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
         1) Over temperature.
         2) Blown fuse.
         3) Component failure.
         4) Overload.
         5) Short circuit.
         6) Ground fault.
         7) DC Bus over voltage.
         8) External safety input (e.g., motor thermal protection).
         9) Logic fault.
      c. When automatic shutdown occurs, VFD shall restart only when remote run signal is removed and reapplied.
      d. VFD shall hold cause of trip data for a minimum of four (4) shutdowns in memory.
         1) Data to be accessible through the keypad.
   2. Input protection:
      a. Input circuit breaker or current-limiting fuses with externally operable disconnect.
         1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
         2) Handle padlockable in the OFF position.
      b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
      c. Incoming line transient suppression.
         1) 6000V peak per IEEE C62.41.
         2) Phase-to-phase and phase-to-ground protection.
      d. Sustained over voltage trip.
   3. Internal protection:
      a. Surge suppression and power device snubbers.
      b. Power devices rated at 2.5 times line voltage.
      c. Instantaneous over current trip.
      d. DC bus over voltage trip.
      e. Power device over temperature trip.
      f. Control logic circuit malfunction trip.

4. Output protection:
    a. Inverse-time overload trip:
        1) UL Class 10 characteristic.
    b. Over voltage trip.
    c. Over frequency trip.
    d. Short circuit trip.
        1) Line to line and line to ground.
    e. Ground fault trip.

2.4 OPERATOR CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface.
    1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available.

B. Control circuits shall be 120 Vac or 24 Vac or 24 Vdc.
    1. 120 Vac supplied by CPT in the VFD.
        a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
        b. CPT shall have two (2) fuses on the primary side and one (1) fuse on the secondary side.
        c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
    2. 24 Vac or 24 Vdc supplied by Class 2 power supply in the VFD.
        a. Power supply shall have minimum additional capacity of 33 percent greater than that required by control devices.
        b. Provide two (2) current-limiting fuses on the AC supply to the power supply.
        c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
    1. Door mounted sealed keypad, membrane type with LED or LCD display.
        a. Messages shall be in English and engineering units.
        b. Drive operating parameters shall be programmable.
        c. Menu driven.
        d. Password security.
        e. Display fault and diagnostic data.
        f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
        g. Gold plated plug-in contacts.
    2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
        a. Minimum indications:
            1) Run.
            2) Stop.
            3) Ready.
            4) Alarm.
            5) Fault.
            6) Local control.
            7) Remote control.
            8) Control source local.
            9) Control source remote.
            10) Speed indication.
        b. Minimum control functions:
            1) Local/Remote switch.
            2) Stop button.
            3) Start button.

4) Reset button.
5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
   a. On occurrence of more than one (1) condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:
1. Local portable computer interface via RS232/RS242 serial communications port:
   a. Capability to:
      1) Start-Stop VFD.
      2) Control VFD Speed.
      3) Access fault and diagnostic data.
2. Analog and discrete inputs:
   a. Speed reference (setpoint) signal 4-20 mA DC.
   b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mADC process variable signal.
3. Analog and discrete outputs:
   a. 4-20 mADC output for remote speed indication, as a function of frequency, calibrated 0 to 100 percent.
   b. Drive FAULT contacts.
   c. Drive RUNNING contacts.
   d. Drive selector switch in REMOTE status contacts.
4. Contacts:
   a. Contacts shall be rated 2 A inductive at 120 Vac.
   b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
   a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
   b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.

2.5 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.

B. With two VFDs operating under worst-case harmonic current conditions, and the facility supplied from the utility, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
2. Current distortion: IEEE 519 Table 10.3 based on calculated I_{SC}/I_L at each PCC.

C. PCC shall be considered:
1. Each MCC, switchboard, switchgear, or panelboard supplying a VFD branch circuit.

D. The Engineer has performed preliminary calculations based on typical VFD data which indicate that the minimum mitigation measures required to meet the specified harmonic criteria are one (1) of the following topologies:
1. 12-pulse rectifier topology for each VFDs.
2. 18-pulse rectifier topology for each VFDs.
3. Active filters or active front end rectifier topology for each VFDs.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.
   1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
   2. Power system data for analysis shall be taken from the Electrical Drawings and approved equipment submittals.
      a. VFDs provided in a package with equipment specified elsewhere, shall be included in the analysis.

G. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.6 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.
   1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:
      a. Inverter duty motors: 1280 V.
      b. Rise time shall be greater than or equal to 0.1 microsecond.
      c. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.

D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10 percent shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.7 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
   1. Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
      a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
      b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
   2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.
   3. Cooling fans, as required, shall be provided to run when drive is running.
   4. Enclosures for separately mounted VFD's:
      a. NEMA Type 1 for installation in Electrical Rooms.
      b. NEMA Type 12 for installation in other unclassified areas.

B. Wiring:
1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
b. Bases with a self-sticking back will not be allowed.
2. All plug-in contacts shall be gold-plated.
3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
a. Provide terminals for shield continuity where required.
4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
a. Non-brittle, interlocking, track-mounted type.
b. Screw terminals will not be allowed.
c. A terminal for each conductor of external circuits plus one (1) ground for each shielded cable.
d. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
e. Not less than 25 percent spare terminals shall be provided.
f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal Drawings.
g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
a. Markings or color code shall match the manufacturer's Drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:
1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10400.
2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.8 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.
2. Prior to final assembly:
a. Inspect incoming components.
b. Test and inspect power devices.
c. Circuit cards:
1) Component and functional tests:
2) Burn-in chamber or temperature cycling test.
3) System test after burn-in or temperature cycling.

3. After final assembly:
    a. Continuity and insulation test of 480 power control circuits.
    b. Drive tests:
        1) Burn-in complete drive at full load for 24 HRS.
        2) Verify all auxiliary circuits operation.
        3) Monitor output variables.
    c. Systems test:
        1) Provide inputs to field connections and simulate on-site operation.
        2) Test all auxiliary equipment.

2.9 MAINTENANCE MATERIALS

A. Provide manufacturers recommended renewable spare parts (e.g., power and control fuses).

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

C. Provide services of manufacturer's representative to perform start-up services.

D. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
    1. The space available on the Drawings shall not be exceeded.

3.2 START UP

A. Pre-start-up Services:
    1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period described in Specification Section 01650.
    2. Shall consist of:
        a. Physical and electrical installation check.
        b. Final adjustments and calibration of drive parameters.
        c. VFD operation from simulated input signals.
    3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:
    1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
        a. For each individual VFD.
        b. For the maximum number of VFDs that will be operational at the same time.
        c. When all loads are at 75 percent load minimum.
        d. Duration: 1 HR minimum.
    2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
        a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
            1) Time shall be measured in microseconds.
        b. Tests shall be performed at full:
            1) Full voltage and speed.
            2) Loaded to 75 percent minimum.
            3) Duration: 1 HR minimum.
    3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
   1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
      a. Perform all work in the presence of the Owner's designated representatives.
   2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
   3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
      a. Ensure compatibility of VFD with associated control and instrumentation signals.
   4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's Designated Personnel:
   1. Minimum of 8 HRS at the jobsite.
   2. Include both field and classroom instruction.
   3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
      a. Lubrication.
      b. Troubleshooting.
      c. Repair and replacement.
      d. Parts inventory.
      e. Maintenance records.

3.3 SCHEDULES

A. Several motors may have full load amps (FLA) greater than that listed in NFPA 70.
   1. The following table is an estimate for the FLA of the motors based on preliminary Shop Drawings.

EQUIPMENT TAG	HP	RPM	ESTIMATED FLA
CWP1	200	1183	255
CWP2	200	1183	255
CWP3	200	1183	255

END OF SECTION

2014/08/28

SECTION 16343
TERMINAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage cable terminal cabinets.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Conditions.
   3. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electronic and Electrical Engineers (IEEE):
      a. C57.12.28, Standard for Pad-Mounted Equipment – Enclosure Integrity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Nameplate data.
      c. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. General arrangement plan view showing door swings, cable entrance locations, etc.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

1.4 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cooper Power Systems.
   2. S&C Electric Company.

3. Shallbetter Inc.
4. Trinetics.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 CABLE TERMINAL CABINETS

A. Ratings:
1. Voltage: 600 V.
2. Amperage: 3000 A.
3. Number of phases: 3.
4. Number of wires: 4 plus ground.
5. Frequency: 60 Hz.
6. Short circuit: 50,000 A
7. UL Listed.

B. Enclosure:
1. Material: 0.125 IN 5052H32 aluminum alloy.
2. All welded construction.
3. Roof cross-kinked for water shedding in all directions.
4. Tamperproof per IEEE and ANSI standards.
5. Front and rear doors with:
   a. Stainless steel hinges and hardware.
   b. Three-point latching mechanism.
   c. Padlockable.
   d. Automatically latching door holders.
6. Lifting provisions.
7. Non-corrosive nameplate.
8. Interior and exterior surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
9. Finish color: Dark green.
   a. Size: 48 IN x 48 IN x 48 IN minimum. Conduit entry space 45 IN x 45 IN minimum.

C. Buses:
1. Material: Tin-plated copper.
2. Minimum of 18 sets of NEMA two hole pattern.
3. Spacing between buses to allow a minimum of 36 cable terminations (back-to-back on each NEMA two hole pattern.
4. Bus supports and standoff insulators: porcelain or epoxy.

D. Basis of Design: Shallbetter Model STEN.

2.3 MAINTENANCE MATERIALS

A. Touch-up paint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Arrange as shown on the Drawings.

C. Pad Mounted Cable Terminal Cabinets:
1. Install on concrete pad per detail on the Drawings.

D. Miscellaneous: Paint any scratched surfaces with touch-up paint.

END OF SECTION

2014/10/07

SECTION 16410
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates safety switch model number with connected equipment tag number.
      c. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Crouse-Hinds.
   7. Killark.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.
   5. Quick-make/quick-break operating mechanism.
   6. Deionizating arc chutes.
   7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
   8. Clear line shields to prevent accidental contact with line terminals.
   9. Operating handle:
      a. Red and easily recognizable.
      b. Padlockable in the OFF position
      c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
   1. Horsepower rated of connected motor.
   2. Voltage and amperage: As indicated on the Drawings.
   3. Short circuit withstand:
      a. Non-fused: 10,000A.
      b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
   1. Neutral kits.
   2. Ground lug kits.
   3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

D. Enclosures:
   1. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
   1. Fuses.
   2. See Specification Section 16490 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
   1. The VFD is to be disabled with the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in non-architecturally finished areas.

END OF SECTION

1

2014/10/03

SECTION 16411
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage switchboard with breaker control system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16490 - Overcurrent and Short Circuit Protective Devices.
   5. Section 16491 - Low Voltage Surge Protective Devices (SPD).
   6. Section 16493 - Control Equipment Accessories.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 2, Deadfront Distribution Switchboards.
   2. Underwriters Laboratories, Inc. (UL):
      a. 891, Standard for Safety Dead-Front Switchboards.

B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. See Specification Section 16010 for additional requirements.
   4. Fabrication and/or layout drawings:
      a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
      b. Front elevation and plan drawing of the assembly.
      c. Three-line or single line and schematic diagrams.
      d. Conduit space locations within the assembly.
      e. Circuit breaker control diagrams.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Fabrication and/or layout drawings updated with as-build conditions

C. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

2. Ground fault protection system test report signed by the projects supervising electrical foreman.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SWITCHBOARDS

A. Ratings:
   1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
   2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
   3. When low voltage power circuit breakers are utilized, the switchboard shall have a 30 cycle withstand rating corresponding to the breaker rating.
   4. Service Entrance Equipment rated when indicated on the Drawings.

B. Construction:
   1. Standards: NEMA PB 2, UL 891.
   2. Completely enclosed, dead-front, self-supporting metal structure.
   3. Vertical panel sections bolted together.
   4. Frames bolted together to support and house bus, cables and other equipment.
   5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
   6. All sections front and rear aligned.
   7. NEMA 3R rated weatherproof enclosure:
      a. Nonwalk-in type with sloping roof downward toward rear.
      b. Thermostatically controlled space heaters to minimize internal condensation.
      c. Power for heater derived internal to the switchboard.
   8. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
   1. Material: Tin-plated aluminum or silver-plated copper.
   2. Main horizontal bus:
      a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane.
      b. Sufficient size to limit temperature rise to 65 DegC over average air temperature outside the enclosure of 40 DegC.
   3. Neutral bus: Fully rated and continuous over length of switchboard.
   4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
   5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
   1. Utility Feeder overcurrent protective device:
      a. Individually mounted, electrically operated, insulated case circuit breaker with arc flash maintenance provision.

2. Standby Service overcurrent protective devices:
    a. Individually mounted, electrically operated, insulated case circuit breaker with arc flash maintenance provision.
3. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
4. Factory installed.
5. Means to padlock all main and feeder devices in the open position.

E. Surge Protective Device: Integrally mounted, see Specification Section 16491.

F. Accessories:
1. Thermograph viewing windows for infrared surveys without opening doors.
2. Arc Flash reduction system with switch and indicating light integrated into the breaker assembly.
3. Main-Generator breaker control system.

G. Operation:
1. Microprocessor based control module.
2. Open transition.
3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
    a. Normal source voltage sensing.
        1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
        2) Adjustable dropout from 75-98 percent of pickup setting, factory set 85 percent.
    b. Emergency source voltage and frequency sensing:
        1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
        2) Fixed voltage dropout at 85 percent of pickup setting.
        3) Adjustable pickup from 90-100 percent of rated frequency, factory set 95 percent.
        4) Fixed frequency dropout at 88 percent of pickup setting.
6. Time delays:
    a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
    b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
    c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
        1) Automatically bypassed when emergency source fails and normal source is available.
    d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
    a. Enable and disable function.
    b. Selectable to exercise with or without transferring load.
    c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
    d. Adjustable day of the week exercise setting, factory set for Monday.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Arrange switchboard as shown on Drawings.

C. Outdoor Location:
   1. NEMA 3R, Non-walk in enclosure.
   2. Install on concrete housekeeping pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad per vendor details.

D. Miscellaneous:
   1. Provide circuit protective devices and other associated equipment as indicated on the drawings.
   2. All control wiring shall be neatly laced and have flexibility at hinged locations.

3.2 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 16490.

B. Automatic Transfer Switch Testing:
   1. Simulate power outage by pulling the PT fuses.
      a. Verify engine generator starts and switch transfers in the specified time.
   2. Simulate the return of normal power.
      a. Verify the switch retransfers and engine generator shuts down in the specified time.
   3. Perform a manual transfer and retransfer.
   4. Verify the indicator lights function properly.

END OF SECTION

2014/08/28

SECTION 16412
SEPARATELY MOUNTED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Separately mounted circuit breakers.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16490 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates equipment model number with equipment tag number.
      c. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Crouse-Hinds.
   7. Killark.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 COMPONENTS

A. NEMA 4 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

B. NEMA 4X rated:
   1. Body and cover: Type 304 or 316 stainless steel.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

C. Standards: UL 489.

D. Overcurrent and short circuit protective devices:
   1. Molded case circuit breaker.
   2. See Section 16490 for overcurrent and short circuit protective device requirements.
   3. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Permitted uses of NEMA 4 enclosure:
   1. Surface mounted in areas designated as wet.

C. Permitted uses of NEMA 4X enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

END OF SECTION

2014/10/07

SECTION 16440
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage switchboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16490 - Overcurrent and Short Circuit Protective Devices.
   5. Section 16491 - Low Voltage Surge Protective Devices (SPD).
   6. Section 16493 - Control Equipment Accessories.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 2, Deadfront Distribution Switchboards.
   2. Underwriters Laboratories, Inc. (UL):
      a. 891, Standard for Safety Dead-Front Switchboards.

B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. See Specification Section 16010 for additional requirements.
   4. Fabrication and/or layout drawings:
      a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
      b. Front elevation and plan drawing of the assembly.
      c. Three-line or single line and schematic diagrams.
      d. Conduit space locations within the assembly.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Fabrication and/or layout drawings updated with as-build conditions

C. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Ground fault protection system test report signed by the projects supervising electrical foreman.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SWITCHBOARDS

A. Ratings:
   1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
   2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
   3. When low voltage power circuit breakers are utilized, the switchboard shall have a 30 cycle withstand rating corresponding to the breaker rating.
   4. Service Entrance Equipment rated when indicated on the Drawings.

B. Construction:
   1. Standards: NEMA PB 2, UL 891.
   2. Completely enclosed, dead-front, self-supporting metal structure.
   3. Vertical panel sections bolted together.
   4. Frames bolted together to support and house bus, cables and other equipment.
   5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
   6. All sections front and rear aligned.
   7. Devices front removable and load connections front accessible for mounting switchboard against a wall.
   8. NEMA 1 rated enclosure.
   9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
   1. Material: Tin-plated aluminum or silver-plated copper.
   2. Main horizontal bus:
      a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane.
      b. Sufficient size to limit temperature rise to 65 DegC over average air temperature outside the enclosure of 40 DegC.
   3. Neutral bus: Fully rated and continuous over length of switchboard.
   4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
   5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Individually mounted insulated case circuit breaker with Arc Flash maintenance provision.
   2. Feeder overcurrent protective devices:
      a. Group mounted molded case circuit breaker.
   3. See Specification Section 16490 for overcurrent and short circuit protective device requirements.

4. Factory installed.
5. Means to padlock all main and feeder devices in the open position.

E. Surge Protective Device: Integrally mounted, see Specification Section 16491.

F. Accessories:
1. Arc flash maintenance key operated switch and indicating light on the front of the gear.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards in accordance with manufacturer's instructions.

B. Arrange switchboard as shown on the Drawings.

C. Indoor Locations:
1. NEMA 1 enclosure.
2. Install on concrete housekeeping pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

D. Miscellaneous:
1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.2 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 16490.

END OF SECTION

1

2014/08/15

SECTION 16441
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lighting and appliance panelboards.
   2. Power distribution panelboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16490 - Overcurrent and Short Circuit Protective Devices.
   5. Section 16491 - Low Voltage Surge Protective Devices (SPD).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Panelboard schedules with as-built conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.
   3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating or as indicated in the schedule.
   4. Service Entrance Equipment rated when indicated on the Drawings.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
   1. Boxes: Code gage galvanized steel, furnish without knockouts.
   2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
   3. Lighting and appliance panelboard:
      a. Trims supplied with hinged door over all circuit breaker handles.
      b. Trims for surface mounted panelboards, same size as box.
      c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
      d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
      e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
      f. Clear plastic cover for directory card mounted on the inside of each door.
      g. NEMA 3R or NEMA 12 rated: Door gasketed.
   4. Power distribution panelboard:
      a. Trims cover all live parts with switching device handles accessible.
      b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
      c. Clear plastic cover for directory card mounted front of enclosure.

d. NEMA 3R or NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.

F. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
a. Molded case circuit breaker.
2. Branch overcurrent protective devices:
a. Mounted molded case circuit breaker.
3. See Section 16490 for overcurrent and short circuit protective device requirements.
4. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 16010.

C. Provide NEMA 1, NEMA 3R or NEMA 12 rated enclosure as indicated on the Drawings.

D. Provide each panelboard with a typed directory:
1. Identify all circuit locations in each panelboard with the load type and location served.
2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on the Drawings.
3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.

END OF SECTION

1

2014/08/15

SECTION 16442
MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Separately mounted motor starters (including those supplied with equipment).
   2. Manual motor starters.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16080 - Acceptance Testing.
   5. Section 16265 - Variable Frequency Drives - Low Voltage.
   6. Section 16490 - Overcurrent and Short Circuit Protective Devices.
   7. Section 16493 - Control Equipment Accessories.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. International Electrotechnical Commission (IEC).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
      b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.

B. Miscellaneous:
   1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
   2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout Drawings:
      a. Separately mounted combination starters:
         1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

c. Fabrication and/or layout drawings updated with as-built conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton.
   3. General Electric Company.
   4. Square D Company.
   5. Siemens.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:
   1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
   2. Circuit breaker and MCP operators includes a separate TRIPPED position.
   3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
   4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
   5. Padlockable in the OFF position.

D. External mounted overload relay pushbutton.

E. Control Devices:
   1. Provide control devices as indicated on the Drawings per Specification Section 16493.
   2. The following devices are the minimum required unless otherwise indicated on the Drawings:
      a. Three-position switch (HAND-OFF-AUTO).
      b. Red ON indicator light.
      c. Non-resetable run time meter.
   3. Devices will be accessible with the door closed.

F. Control Power Transformer:
   1. 120V secondary.
   2. Fused on primary and secondary side.
   3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
   1. Motor circuit protector.

2. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
3. Factory installed.

2.3 MOTOR STARTERS

A. Standards:
1. NEMA ICS 2.
2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
1. NEMA full size rated contactor, size one minimum.
a. NEMA half sizes and IEC contactors are not permitted.
2. Double-break silver alloy contacts.
3. Overload relays:
a. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.
4. Interlock and auxiliary contacts, wired to terminal blocks:
a. Holding circuit contact, normally open.
b. Overload alarm contact, normally open.
c. Normally open auxiliary contact, for remote run status.
d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
e. Two (2) additional normally open spare field replaceable auxiliary contacts.

C. Variable Frequency Drives: See Specification Section 16265.

2.4 MANUAL MOTOR STARTERS

A. Standards:
1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
1. Horsepower rated, for ON/OFF control and thermal overload protection.
a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
1. NEMA 1 rated:
a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
b. With or without concentric knockouts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 16010.

C. Overload Heaters: Size for actual motor full load current of the connected motor.

D. Combination and Manual Starter Enclosures:
1. Permitted uses of NEMA 1 enclosure:
a. Surface mounted in non-architecturally finished areas.

2. Permitted uses of NEMA 12 enclosure: Surface mounted in areas designated as dry.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 16080.

END OF SECTION

2014/08/28

SECTION 16460
DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-type transformers, 1000 kVA and less.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16060 - Grounding.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.12.01, Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin-Encapsulated Windings.
      b. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry-Type Transformers for General Applications.
      c. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 506, Standard for Safety Specialty Transformers.
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Nameplate drawing.
   4. Certifications:
      a. Sound level certifications.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Sola/Hevi-Duty.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two (2) winding type.

B. Cores:
   1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
   2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Non-ventilated Units:
   1. Core and coil assembly encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock resistant seal.
   2. Totally enclosed, NEMA 3R, steel enclosure finished with a weather-resistant enamel.

E. Ventilated Units:
   1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
   2. Drip proof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

F. Furnish Taps for Transformers as follows:
   1. 1 PH, 3 to 25 kVA: Two (2) 5 percent FCBN.
   2. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

G. Sound Levels:
   1. Manufacturer shall guarantee not to exceed the following:
      a. 10 to 50 kVA: 45 dB.

H. Efficiency:
   1. Ventilated, 15 kVA and larger: Energy efficient meeting NEMA TP 1 requirements.
   2. Non-ventilated: Standard efficiency.

I. Insulating Material (600 V and below):
   1. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

J. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

K. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

L. Standards: IEEE C57.96, NEMA ST 20, NEMA TP 1, UL 506, UL 1561.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.
   2. Provide non-ventilated type for 9 kVA units and below and were indicated on the Drawings.
   3. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 16010.
   4. Provide rubber vibrations isolation pads.

C. Outdoor Locations:
   1. Provide non-ventilated type.
   2. Mount ventilated type with weather shields on a concrete pad.
   3. Mount non-ventilated type on concrete pad for units weighting greater than 400 LBS and mount units weighting less than 400 LBS on channel support structure per detail on Drawings.

D. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.

E. Ground in accordance with Section 16060.

END OF SECTION

1

2014/08/28

SECTION 16490
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16080 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
      b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489)
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      b. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
      c. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Ground fault protection system test reports signed by the projects supervising electrical foreman.

3. Reports:
    a. As-left condition of all circuit breakers that have adjustable settings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Circuit breakers:
        a. Eaton.
        b. General Electric Company.
        c. Square D Company.
        d. Siemens.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:
    1. General:
        a. Standards: NEMA AB 1, UL 489.
        b. Unit construction.
        c. Over-center, toggle handle operated.
        d. Quick-make, quick-break, independent of toggle handle operation.
        e. Manual and automatic operation.
        f. All poles open and close simultaneously.
        g. Three (3) position handle: On, off and tripped.
        h. Molded-in ON and OFF markings on breaker cover.
        i. One-, two- or three-pole as indicated on the Drawings.
        j. Current and interrupting ratings as indicated on the Drawings.
        k. Bolt on type.
    2. Thermal magnetic type:
        a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
        b. Frame size 150 amp and below:
            1) Non-interchangeable, non-adjustable thermal magnetic trip units.
        c. Frame sizes 225 to 400 amp (trip settings less than 400A):
            1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
        d. Ground Fault Circuit Interrupter (GFCI) Listed:
            1) Standard: UL 943.
            2) One- or two-pole as indicated on the Drawings.
            3) Class A ground fault circuit.
            4) Trip on 5 mA ground fault (4-6 mA range).
    3. Solid state trip type:
        a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
        b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
            1) Standard rating.
            2) Interchangeable current sensor or rating plug.
            3) Adjustable long time pick-up setting.
                a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
            4) Adjustable short time pick-up setting.
            5) Adjustable instantaneous pick-up.
            6) Fixed ground fault pick-up, when indicated on the Drawings.

c. Frame size 1600 amp and above:
1) 100 percent rated.
2) Interchangeable current sensor or rating plug.
3) Adjustable long time pick-up setting.
a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
4) Adjustable long time delay setting.
5) Adjustable short time pick-up setting.
6) Adjustable instantaneous pick-up setting.
7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
8) Adjustable ground fault delay setting, when indicated on the Drawings.

4. Motor circuit protector:
a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
b. Sized for the connected motor.

B. Insulated Case Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: NEMA AB 1, UL 489.
3. 100 percent rated.
4. Manually operated (MO) unless electrically operated (EO) is indicated on the Drawings.
5. Electrically operated breakers:
a. 120 Vac operators.
b. Close/open pushbuttons.
c. Red and green indicators to indicated breaker position.
d. AC source: Control power transformer internal to the switchgear.
6. Motor driven operator for charging mechanism with open, close and charge push button.
7. Current and interrupting ratings as indicated on the Drawings.
8. Frame size 400 amp and above:
a. Interchangeable current sensor or rating plug:
b. Adjustable long time pick-up setting.
1) Adjustable from 50 to 100 percent of the current sensor or rating plug.
c. Adjustable long time delay setting.
d. Adjustable short time pick-up setting.
e. Adjustable instantaneous pick-up setting.
f. Adjustable ground fault pick-up setting, when indicated on the Drawings.
g. Adjustable ground fault delay setting, when indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
b. Frame sizes 800 amp and larger shall be solid state trip type.
c. Frame sizes 1000 amp and above shall include integral ground fault protection, when indicated on the Drawings.

d. Motor circuit protectors sized for the connected motor.

2. Insulated case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
   a. Set current sensor or rating plugs long time pick-up setting so that the indicated trip level is near the 75 percent trip point.
   b. Frame sizes 1000 amp and above shall include integral ground fault protection, when indicated on the Drawings.

3.2 FIELD QUALITY CONTROL

A. Adjustable Circuit Breakers:
   1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

B. Ground Fault Protection System:
   1. Single source system:
      a. Main breaker using the residual sensing method system.
      b. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

C. Testing:
   1. Acceptance testing: See Specification Section 16080.

END OF SECTION

2014/08/28

SECTION 16491
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type 3 SPD - Medium exposure locations (switchboard, panelboard and motor control center), integrally mounted.
   2. Type 4 SPD - Medium exposure location (switchboard, panelboard and motor control center), externally mounted.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. LS 1, Low Voltage Surge Protective Devices.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer's qualifications.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Testing procedures and testing equipment data.
      e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
         1) Data in the Product Data Sheet heading:
            a) SPD Type Number per PART 2 of the Specification.
            b) Manufacturer’s Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer’s certified value confirming the product meets the specified value/feature.
            c) Name of the nationally recognized testing laboratory that preformed the tests.
            d) Warranty information.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer’s official (printed and signed).
            b) Title of the official.

4) Date of signature.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of the Operation and Maintenance Manuals.
   2. Warranty.

1.5 WARRANTY

A. Minimum of a five (5) year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, NEMA LS 1, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE 3 SPD

A. Product:
   1. Integrally mounted in a switchboard, panelboards or motor control centers.
   2. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   3. Do not connect multiple SPD modules in series to achieve the specified performance.
   4. Designed for parallel connection.
   5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   6. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 160,000 A per phase, 80,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41 B Comb. Wave	IEEE C62.41 B3 Ring Wave	UL 1449
L-L < 250 V	L-L	1000 V	700 V	800 V
L-N < 150 V	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V	L-L	2000 V	1400 V	1800 V
L-N > 150 V	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 TYPE 4 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to CTC cabinet.
   2. Externally mounted next to Switchgear, Switchboards or Motor Control Centers.
   3. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other suppression system components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   4. Do not connect multiple SPD modules in series to achieve the specified performance.
   5. Designed for parallel connection.
   6. Enclosure:
      a. Metallic NEMA 4 or 12 for interior locations.
      b. Metallic NEMA 4 or 4X for exterior locations.
   7. Field connection:
      a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors.
   8. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
      b. A fuse status only monitor system is not acceptable.
   9. Accessories (when specifically specified): Unit mounted disconnect switch.

B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Maximum Surge Current: 120,000 A per phase, 60,000 A per mode minimum.

G. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

H. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

I. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

J. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.4 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
   1. Integral unit level and/or component level fusing.
   2. Neutral and ground shall not be bonded during testing.
   3. 6 IN lead lengths.
   4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
   1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
   2. Single pulse surge current capacity test.
   3. Repetitive surge current capacity testing.
   4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type 3 SPD:
   1. Connected in parallel to the equipment.
   2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
   3. Provide leads that are as short and straight as possible.
   4. Maximum lead length: 12 IN.
   5. Minimum lead size: #2 stranded AWG or bus bar.
   6. Connect leads to the equipment to be protected by one (1) of the following means:
      a. Through a circuit breaker or molded case switch mounted in the equipment.
      b. Use manufacturer recommended circuit breaker size.
      c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

C. Type 4 SPD:
   1. Mounting options:
      a. Nipple connection directly to the equipment to be protected.

2. Install leads as short and straight as possible.
3. Maximum lead length: 5 FT.
4. Minimum lead size:
   a. #2 stranded AWG.
5. When conduit connection is used, provide a minimum of four (4) twists per foot in the lead conductors and install in NFPA 70 sized conduit.
6. Connect leads to the equipment to be protected by one (1) of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
      1) Use manufacturer recommended circuit breaker size.
   b. Directly to the protected equipment bus, when SPD has integral disconnect switch.

END OF SECTION

2014/08/28

SECTION 16493
CONTROL EQUIPMENT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Control panels and operator stations.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Safety Industrial Control Panels.

B. Miscellaneous:
   1. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. Control panel bill of material.
      c. See Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Control panel interior and exterior layout.
      b. Control panel wiring diagrams.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pilot devices and relays:
      a. Idec.
      b. Potter & Brumfield.
      c. ATC Diversified Electronics.
   2. Contactors:
      a. Automatic Switch Company (ASCO).
      b. Eaton.
      c. General Electric Company.
      d. Square D Company.
      e. Siemens.
      f. Allen Bradley.
   3. Photocells:
      a. Grasslin.
      b. Tork.
      c. Intermatic.
      d. Paragon.
   4. Terminal blocks:
      a. Phoenix Contact.
      b. Allen-Bradley.
   5. Enclosures:
      a. Hoffman Engineering Co.
      b. Wiegmann.
      c. Eaton B-Line.
      d. Adalet.
      e. Stahlin.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PILOT DEVICES

A. General Requirements:
   1. Standards: NEMA ICS 2, UL 508.
   2. Heavy-duty NEMA 4/13 watertight/oiltight.
   3. Mounting hole: 30.5 mm.
   4. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
   5. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
   1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
   2. Maintained contact type.
   3. Knob or lever type operators.

C. Pushbuttons:
   1. Non-illuminated type:
      a. Protective boot.
      b. Momentary contact.
      c. Standard flush and mushroom operators.
      d. Red colored buttons for START or ON and green color for STOP or OFF.
      e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.

D. Indicating Lights:
   1. Allowing replacement of bulb without removal from control panel.
   2. Lamp: LED, 120 V or 24 V as required.
   3. Full voltage type.
   4. Push-to-test indicating lights.
   5. Glass lens.
   6. Color code lights as follows:
      a. Green: OFF or stopped valve open.
      b. Amber: Standby; auto mode; ready.
      c. Red: ON or running; valve closed.

2.3 RELAYS

A. General Requirements:
   1. Standards: NEMA ICS 2, UL 508.

B. Control Relays:
   1. General purpose (ice cube) type:
      a. Plug-in housing.
      b. Clear polycarbonate dust cover with clip fastener.
      c. Coil voltage: 120 Vac or as required.
      d. Contacts:
         1) 10 amp continuous.
         2) Silver cadmium oxide.
         3) Minimum of 3 SPDT contacts.
      e. Sockets: DIN rail mounted.
      f. Internal neon or LED indicator is lit when coil is energized.
      g. Manual operator switch.
   2. Industrial type:
      a. Coil voltage: 120 Vac or as required.
      b. Contacts:
         1) 10 amp, NEMA A600 rated.
         2) Double break, silver alloy.
         3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
         4) Expandable from 2 poles to 12 poles.
      c. Provide contacts for all required control plus two spares.

C. Time Delay Relays:
   1. General purpose type:
      a. Timing modes: On and Off delay, interval, one shot and repeat cycle.
      b. Plug-in housing.
      c. Polycarbonate dust cover with clip fastener.
      d. Coil voltage: 120 Vac or as required.
      e. Contacts:
         1) 10 amp continuous.
         2) Silver cadmium oxide.
         3) Two normally open and two normally closed DPDT contacts.
         4) Instantaneous contact as well as timed.
      f. Sockets: DIN rail mounted.
      g. External timing adjustment knob.
      h. Timing ranges: 0.05 seconds to 16.65 HRS.
      i. Repeat accuracy: +1 percent.
   2. Solid State industrial type:
      a. Timing modes: On and Off delay and repeat cycle.
      b. Industrial housing.
      c. Coil voltage: 120 Vac or as required.

d. Contacts:
   1) 5 amp, NEMA B150 rated.
   2) Silver alloy.
   3) Convertible On Delay and Off Delay contacts.
   4) Normally open and normally closed timed contacts or interposing relays as required.
   5) Normally open and normally closed instantaneous contacts or interposing relays as required.
e. Furnish with "on" and "timing out" indicators.
f. External timing adjustment knob.
g. Timing ranges: 0.05 seconds to 10 HRS.
h. Repeat accuracy: +1 percent.

2.4 CONTACTORS

A. General Requirements:
   1. Standards: NEMA ICS 2, UL 508.

B. Definite Purpose:
   1. Coil voltage: 120 Vac or as required.
   2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
   3. Resistive load and horsepower rated.
   4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
   5. Auxiliary contacts, as indicated on Drawings or as specified.

2.5 PHOTOCELLS AND TIME CLOCKS

A. Photocells:
   1. Weatherproof enclosure.
   2. Adjustable turn-on range, initially set at 1.0 footcandles.
      a. Turn-off level approximately three times turn-on.
   3. Provide time delay device to eliminate nuisance switching.
   4. Voltage, amperage and/or wattage ratings as required for the application.

2.6 MISCELLANEOUS DEVICES

A. Run Time Meters:
   1. Six-digit wheels including a 1/10 digit.
   2. Non-reset type.
   3. Time range in hours.
   4. Automatic recycle at zero.
   5. Accuracy: 1 percent.
   6. Sealed against dirt and moisture.
   7. Tamperproof.

2.7 TERMINATION EQUIPMENT

A. General Requirements:
   1. Modular type with screw compression clamp.
   2. Screws: Stainless steel.
   3. Current bar: Nickel-plated copper alloy.
   4. Thermoplastic insulation rated for -40 to +90 DegC.
   5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
   6. End sections and end stops at each end of terminal strip.
   7. Machine-printed terminal markers on both sides of block.
   8. Spacing: 6 mm.
   9. Wire size: 22-12 AWG.
   10. Rated voltage: 600 V.

11. DIN rail mounting.

B. Standard-type block:
   1. Rated current: 30 A.
   2. Color: Gray body.

C. Bladed-type disconnect block:
   1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
   2. Rated current: 10 A.
   3. Color:
      a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
      b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-type block:
   1. Electrically grounded to mounting rail.
   2. Terminal ground wires and analog cable shields.
   3. Color: Green and yellow body.

E. Fuse Holders:
   1. Blocks can be ganged for multi-pole operation.
   2. Spacing: 9.1 mm.
   3. Wire size: 30-12 AWG.
   4. Rated voltage: 300 V.
   5. Rated current: 12 A.
   6. Fuse size: 1/4 x 1-1/4.
   7. Blown fuse indication.
   8. DIN rail mounting.

2.8 ENCLOSURES

A. Control Panels:
   1. NEMA 4 rated:
      a. Seams continuously welded and ground smooth.
      b. No knockouts.
      c. External mounting flanges.
      d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
      e. Cover with oil resistant gasket.
   2. NEMA 4X rated:
      a. Body and cover: 14 GA Type 304 or 316 stainless steel.
      b. Seams continuously welded and ground smooth.
      c. No knockouts.
      d. External mounting flanges.
      e. Hinged door and stainless steel screws and clamps.
      f. Door with oil-resistant gasket.
   3. NEMA 12 enclosure:
      a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. No knockouts.
      c. External mounting flanges.
      d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
      e. Flat door with oil resistant gasket.
   4. Control panel miscellaneous accessories:
      a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
      b. Interiors shall be white or light gray in color.

c. Wire management duct:
1) Bodies: PVC with side holes.
2) Cover: PVC snap-on.
3) Size as required.
d. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
e. Split covers when heavier than 25 LBS.
f. Floor stand kits made of same material as the enclosure.
g. Weldnuts for mounting optional panels and terminal kits.
h. Ground bonding jumper from door, across hinge, to enclosure body.

5. Standards: NEMA 250, UL 508.

B. Operator Control Stations:
1. NEMA 4X rated:
a. Type 304 or 316 stainless steel body.
b. Gasketed Type 304 or 316 stainless steel cover.
c. Number of device mounting holes as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
1. Size as required to mount the equipment.
2. Permitted uses of NEMA 4 enclosure:
a. Surface mounted in areas designated as wet.
3. Permitted uses of NEMA 4X enclosure:
a. Surface mounted in areas designated as wet.
4. Permitted uses of NEMA 12 enclosure:
a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas.

C. Operator Control Stations:
1. Permitted uses of NEMA 4/13 enclosure:
a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas and wet.

3.2 FIELD QUALITY CONTROL

A. See Section 16010.

END OF SECTION

2014/08/28

SECTION 16500
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building lighting fixtures.
      b. Exterior building and site lighting fixtures.
      c. Lamps.
      d. Ballasts.
      e. Lighting control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 16010 - Electrical: Basic Requirements.
   4. Section 16120 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. Certified Ballast Manufacturers (CBM).
   3. Federal Communications Commission (FCC):
      a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
   5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.
      b. C82.4, Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
      c. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 101, Life Safety Code.
   7. Underwriters Laboratories, Inc. (UL):
      a. 924, Standard for Emergency Lighting and Power Equipment.
      b. 935, Standard for Fluorescent-Lamp Ballasts.
      c. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
      d. 1598, Luminaires.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. Identify fixtures by Fixture Schedule number.
c. Fixture data sheet including:
1) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
d. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Lighting fixtures: See Fixture Schedule.
2. Lamps:
a. Osram/Sylvania.
b. General Electric.
c. Philips.
d. Venture.
3. Ballasts: Fixture manufacturer's standard.
4. Emergency ballasts: Bodine.
5. Emergency transfer devices: Bodine.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 GENERAL REQUIREMENTS

A. All lighting fixtures and electrical components:
1. UL labeled.
2. Fixtures complete with lamps and ballasts.
3. Rated for area classification as indicated on the Drawings.

B. Provide standard plaster frame for all recessed lighting fixtures installed in plaster walls or ceilings.
1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

C. No live parts normally exposed to contact.

D. When intended for use in wet areas: Mark fixtures "Suitable for wet locations."

E. When intended for use in damp areas: Mark fixtures "Suitable for damp locations" or "Suitable for wet locations."

2.3 LIGHT FIXTURES

A. Fluorescent:
1. UL 1598.
2. Finish:
a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
b. Manufacturer's standard color or special color specified in Fixture Schedule.
3. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.

B. High Intensity Discharge:
1. UL 1598.
2. Finish:
a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
b. Manufacturer's standard color or special color specified in Fixture Schedule.

3. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.
4. Provided with safety chain.

C. Exit Signs and Emergency Lighting Units:
1. UL 924, NFPA 101.

2.4 LAMPS

A. Fluorescent:
1. T8 (265 mA) instant or rapid-start medium bipin lamps.
a. Correlated color temperature of 3500 degrees Kelvin.
b. Minimum color rendering index (CRI) of 70.
c. Minimum initial lumen ratings for each lamp type shall be:
1) 1300 lumens for 24 IN, 17 watt F17T8 lamp.
2) 2025 lumens for 36 IN, 25 watt F25T8 lamp.
3) 2800 lumens for 48 IN, 32 watt F32T8 lamp.
4) 5700 lumens for 96 IN, 59 watt F96T8 lamp.
2. T5 instant or rapid-start 4 pin (2G11 base) compact fluorescent lamps.
a. Correlated color temperature of 4100 degrees Kelvin.
b. Minimum color rendering index (CRI) of 80.
c. Minimum initial lumen ratings for each lamp type shall be:
1) 1250 lumens for 10.5 IN, 18 watt F18BX lamp.
2) 1800 lumens for 12.8 IN, 24 or 27 watt F27BX lamp.
3) 2850 lumens for 16.5 IN, 36 or 39 watt F39BX lamp.
4) 3150 lumens for 22.5 IN, 39 watt F39BX lamp.
3. T4 twin-tube, quad-tube, and/or triple twin-tube compact fluorescent lamps.
a. Correlated color temperature of 4100 degrees Kelvin.
b. Minimum color rendering index (CRI) of 80.
c. Minimum initial lumen ratings for rapid-start 4-pin triple twin-tube lamps with a GX24q-2 or GX24q-3 base shall be:
1) 1120 lumens for 4.6 IN, 18 watt CF18TTT lamp.
2) 1610 lumens for 5.2 IN, 26 watt CF26TTT lamp.
3) 2200 lumens for 5.8 IN, 32 watt CF32TTT lamp.
4) 3200 lumens for 6.3 IN, 42 watt CF42TTT lamp.

B. High Intensity Discharge (HID) Lamps:
1. Metal halide lamps:
a. Metal halide lamps shall be pulse-start type.
1) If used in an open luminaire, the lamp shall be rated for use in an open fixture and incorporate a protective arc tube shroud design.
b. Clear lamps:
1) Correlated color temperature of 4000 degrees Kelvin.
2) Minimum color rendering index (CRI) of 65.
c. Minimum initial lumen ratings for metal halide lamps with a medium base in a vertical position shall be:
1) 14250 lumens for 150 watt, ED-17 (ANSI M102) clear lamp.
2) 17500 lumens for 175 watt, ED-17 (ANSI M137) clear lamp.
d. Minimum initial lumen ratings for metal halide lamps with a mogul base in a vertical position shall be:
1) 14250 lumens for 150 watt, ED-28 (ANSI M102) clear lamp.
2) 17500 lumens for 175 watt, ED-28 (ANSI M137) clear lamp.

2.5 BALLASTS

A. Fluorescent Electromagnetic Ballasts:
1. UL 935.
2. High-efficiency energy saving electromagnetic core and coil design.

3. CBM certification for full light output.
4. Operate lamps at a frequency of 60 Hz.
5. Power factor: Greater than 90 percent.
6. Input current with Total Harmonic Distortion (THD) of less than 32 percent.
7. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.1.
8. Ballast factor: Greater than the following per NEMA/ANSI C82.1:
   a. 0.925 for rapid start 265 mA (T8) and 430 mA (T12) ballasts.
9. Audible noise rating: Greater than or equal to the following:
   a. Class A for rapid start 265 mA (T8) and 430 mA (T12) ballasts.
10. Coil temperature not to exceed 65 DegC (150 DegF) temperature rise over 40 DegC (105 DegF) ambient.
    a. Maximum case temperature not to exceed 90 DegC (195 DegF).
11. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.
12. Meet all applicable ANSI and IEEE standards regarding harmonic distortion and transient protection such as IEEE C62.41, Cat. A, for transient protection.
13. UL listed, Class P.
14. Fully encapsulated (potted) to ensure maximum thermal and structural integrity.
15. Contain no polychlorinated biphenyls (PCB's).

B. Fluorescent High Frequency Electronic Ballasts:
1. UL 935.
2. "High Frequency" electronic operating lamps at a frequency of 20 KHz or higher without visible flicker.
3. Power factor: Greater than 90 percent.
4. Input current total harmonic distortion (THD) of less than 20 percent.
5. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.11.
6. Instant start with lamps wired in parallel.
7. Support a sustained short to ground or open circuit of any output leads without damage to the ballast.
8. Ballast Factor: Greater than 0.85 per NEMA/ANSI C82.11.
9. Audible noise rating: Class A or better.
10. Operation in ambient temperatures up to 40 DegC (105 DegF) without damage.
11. Light output to remain constant for a line voltage fluctuation of +5 percent.
12. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.
13. Meet NEMA/ANSI C82.11 standards regarding harmonic distortion.
14. Meet IEEE C62.41 Cat. A for transient protection.
15. Comply with all applicable state and federal efficiency standards.
16. UL listed, Class P.
17. Contain no Polychlorinated Biphenyls (PCB's).

C. Fluorescent Emergency Ballasts:
1. UL 924, NFPA 101.
2. High temperature, 24 Watt-hour, maintenance-free nickel cadmium battery with charger.
3. Charging indicator light (LED) to monitor the charger and battery.
4. Double-pole test switch.
5. Light one (1) lamp for 90 minutes in 1, 2 and 3-lamp fixtures.
6. Dual input voltage (120/277V), 4 Watts input.
7. Compatible with the install lamp type.
8. Initial lumen output: 975 to 1400.
9. Contain no Polychlorinated Biphenyls (PCB's).

D. High Intensity Discharge Ballasts:
1. NEMA/ANSI C82.4, UL 1029.

2. Metal halide:
    a. Input voltage variation: +10 percent.
    b. Maximum lamp regulation spread: 20 percent.
    c. Minimum power factor: 90 percent.
    d. Starting current: Not greater than operating current.
    e. Maximum input voltage dip: 40 percent.
    f. Crest factor: 1.5 to 1.8.
    g. Types:
        1) Lead-type regulators: Constant wattage autotransformer (CWA) and pulse start.
        2) Lag-type regulators: Magnetic regulator and pulse start.
    h. Contain no Polychlorinated Biphenyls (PCB's).
3. Ballasts for interior use:
    a. Encased and potted type.
    b. Audible noise rating of B or better.
    c. Built-in automatic resetting thermal protection switch.
4. Ballasts for exterior use:
    a. Starting temperature: -20 DegF.

2.6 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 percent of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 percent of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate fixture types with ceiling construction.
    1. Provide mounting hardware for the ceiling system in which the fixture is to be installed.

B. Provide mounting brackets and/or structural mounting support for wall-mounted fixtures.
    1. Do not support fixture from conduit system.
    2. When fixtures are supported from outlet boxes, install per NFPA 70.
    3. Supports for fixtures mounted on exterior walls shall not be attached to exterior face of the wall.

C. Provide pendant HID fixtures with swivel hangers which will allow fixture to swing in any direction but will not permit stem to rotate.
    1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
    2. Swivel hangers for fixtures in mechanical equipment areas: Shock absorbing type.
    3. Secure HID fixtures with safety chain.

D. Pendant mounted, open, industrial fluorescent fixtures:
    1. Not in continuous rows, shall be supported by conduit or by approved chains:
        a. Hardwired to ceiling mounted junction box.

E. Mount lighting fixtures at heights indicated in Specification Section 16010 or per fixture schedule or as indicted on the Drawings.

F. Install exterior fixtures so that water can not enter or accumulate in the wiring compartment.

G. Ground fixtures and ballasts.

3.2 ADJUST AND CLEAN

A. See Specification Section 01710.

B. Replace all inoperable lamps with new lamps prior to final acceptance.

C. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION