SECTION 031115 – CONCRETE FORMWORK FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the design, installation and removal of forms for cast-in-place concrete.

B. Related sections include the following:

1. Division 03 Section "Concrete Reinforcement For Steam Utility Distribution."
2. Division 03 Section "Concrete Accessories for Steam Utility Distribution."
3. Division 03 Section "Cast-In-Place Concrete for Steam Utility Distribution."

C. Division of Work:

1. In accordance with the General Conditions, Contractor is responsible for dividing the Work among the Subcontractors and Suppliers and for delineating the work to be performed by specific trades.

2. The following are suggestions as to how the Work may be divided. This is not a complete list of all the work:

a. Mechanical, electrical and plumbing trades: Supply, locate and install premanufactured items including inserts, sleeves, and other embedded items required by those respective trades.

b. Formwork Subcontractor:

1) Supply and install site fabricated box-outs for chases, sleeves and other miscellaneous openings for mechanical, electrical and plumbing trades.

2) Install other inserts, embedded parts, box-outs for openings, chases, reveals and recesses, except those specifically mentioned above that are by mechanical, electrical or plumbing trades. Special inserts, embedded parts or other special requirements needed by a specific trade shall be supplied by that trade to the formwork Subcontractor for installation.

c. Contractor: Coordinate location of mechanical, electrical and plumbing inserts, embedded parts, openings and recesses with respective trades.

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with the following:

1. American Concrete Institute:

a. ACI 301 - Specifications for Structural Concrete for Buildings.
b. ACI 347 - Recommended Practice for Concrete Formwork.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Form construction:

1. Provide required forms, shores, bracing, breast timbers, form ties, and accessories and in sufficient quantities so as not to delay the Work.

2. Provide removable panels for inspection and cleaning.

3. Provide chamfered strips in exposed corners of concrete stair stringers, piers, columns, beams, spandrels, internal corners and for similar conditions throughout the Work.

4. Apply form release agent in accordance with manufacturer's instructions. Do not allow to stand in puddles in the forms and prevent bonding of concrete at construction joints.

5. Construct forms to allow for installation of waterstops.

6. Thoroughly clean embedded waterstops and concrete surfaces prior to constructing forms for the next pour.

7. Tie waterstops up to prevent folding while placing concrete.

8. Coordinate work of other sections and cooperate with trade involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchor and other inserts. Do not perform work unless specifically indicated on Drawings or reviewed prior to installation.

9. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses and the like to prevent swelling and for easy removal.

10. Provide temporary openings where interior area of formwork is inaccessible for cleanout, inspection before concrete placement and placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

1.5 QUALITY ASSURANCE

A. Design: The design and engineering of formwork, as well as its construction, shall be the responsibility of Contractor.

B. Notifications: Notify Engineer at least 24 hours in advance of placing concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Formwork facing materials:

1. As-cast, smooth form finish areas:

a. Location: All surfaces.

b. The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper; or other approved material capable to producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection (see ACI 301, Table 4.3.1 for tolerances). Material with raised grain, torn surfaces, worn edges, patches, dents or other defects which will impair the texture of the concrete surface shall not be used.

2. Deflection: Maximum deflection of forms shall be 1/240 of span or 1/4-inch, whichever is less.

B. Form ties:

1. At as-cast, smooth form finish areas:

a. Use steel rod, snap type; or wood cone, snap type, adjustable in length and of type which will leave no metal within 3/4-inch of surface.

b. Ties shall not be fitted with any device which will leave a hole larger than 7/8-inch diameter.

c. Working assembly as job conditions require.

2. For concrete walls, in addition to the above requirements, also provide waterstop type feature on the tie.

C. Form release agent: Use a chemically neutral agent in hydrocarbon solvent that will effectively prevent absorption of moisture and prevent bond with the concrete. Magic Kote by Symons, Crete-lease 727 by Cresset Company; or equal.

PART 3 - EXECUTION

3.1 ERECTION

A. Install wall form ties in a regular repetitive pattern.

B. Embedded items: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of the respective items.

C. Cleaning: Clean forms as erection proceeds, to remove foreign matter. Remove cuttings, shavings and debris from within forms. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports. Retighten forms after concrete placement if required to eliminate mortar leaks.

D. Applying form release agent:

1. Temperature of release agent and surfaces to which it is applied shall be a minimum of 70 degrees F.

2. Apply release agent by spray only.

3. Uniformly coat all surfaces with a thin film.

4. Wipe off excess with clean towels.

5. Apply in strict accordance with manufacturer's recommendations.

E. Form and support removal:

1. Forms and supports shall remain in place for not less than the following periods of time:

   a. Walls: 12 to 24 hours.

2. In any event, do not remove until concrete in walls has reached 30% of design strength, and in structural members and slabs has reached 75% of design strength.

3. Special precautions shall be taken when concrete is placed in average temperatures of 50 degrees F or below to ensure that forms are not removed before design strengths mentioned above are met.

4. If high-early-strength cement is used, the periods of time may be reduced as allowed by Engineer. This does not relieve Contractor of Contractor’s liability.

5. Remove forms in such a manner and at such times as required to ensure complete safety of persons involved and so as to fully protect and maintain structural integrity of members.

6. When the formwork is removed, cure the exposed concrete as specified under Division 03 Section "Cast-in-Place Concrete for Steam Utility Distribution."

7. Particular care shall be taken in removing forms to minimize damage to concrete surfaces.

3.2 FIELD QUALITY CONTROL

A. Inspect and check completed formwork, shoring and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties and parts are secure.

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

C. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten clean surfaces and tighten forms to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces. Do not use metal cover plates for repairing defects in forms for exposed concrete work.

D. Inform Engineer when formwork is complete and has been cleaned, to allow for inspection. Obtain review prior to placing concrete.

E. Allow Engineer to inspect each section of plywood type formwork prior to reuse.

END OF SECTION 031115

SECTION 031515–CONCRETE ACCESSORIES FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the furnishing and installation of concrete accessories.

B. Related sections include the following:

1. Division 03 Section "Concrete Formwork for Steam Utility Distribution."
2. Division 03 Section "Concrete Reinforcement for Steam Utility Distribution."
3. Division 03 Section "Cast-In-Place Concrete for Steam Utility Distribution."

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with ASTM Standard Specifications: D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Inserts for general trades:

1. Halfen Anchoring Systems; Heckman Building Products; Hohmann & Barnard, Inc.; or equal.

2. Malleable iron and steel, strength as required.

3. Include bolts, nuts and washers.

4. All steel shall be galvanized.

B. Waterproof bead:

1. Waterstop RX by CETCO; or equal.
2. 3/4-inch x 3/8-inch.
3. Provide at joints marked WSJ on Drawings and at all other joints in slabs and walls.

C. Other materials: All other materials not specifically described but required for a complete and proper installation of concrete accessories shall be as selected by Contractor subject to the approval of Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install concrete accessories:

1. As indicated on the Drawings.
2. As specified in various other sections.
3. As necessary for the proper and complete performance of the Work.

B. Waterproof bead:

1. Install in joints at last convenient time of accessibility.
2. Apply in strict accordance with manufacturer's instructions.

C. Piping, mechanical and electrical equipment support: Refer to Division 03 Section "Concrete Formwork for Steam Utility Distribution."

END OF SECTION 031515

SECTION 032015 – CONCRETE REINFORCEMENT FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the furnishing and placement of concrete reinforcement.

B. Related sections include the following:

1. Division 03 Section "Concrete Formwork for Steam Utility Distribution."
2. Division 03 Section "Concrete Accessories for Steam Utility Distribution."
3. Division 03 Section "Cast-In-Place Concrete for Steam Utility Distribution."

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with the following:

1. American Concrete Institute (ACI):

   a. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.

   b. 315 - Details and Detailing of Concrete Reinforcement.

   c. 315R - Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.

   d. 318 - Building Code Requirements for Reinforced Concrete.

2. American Society of Testing and Materials (ASTM) Specifications:

   a. A 185 - Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.
   b. A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

3. American Welding Society (AWS):

   a. D1.4: Structural Welding Code - Reinforcing Steel.

4. Concrete Reinforcing Steel Institute (CRSI):

   a. Manual of Standard Practice.
   b. Placing Reinforcing Bars.

1.4 SUBMITTALS

A. Shop Drawings for concrete reinforcement to include:

1. Number, size, length, mark, and location of concrete reinforcement.
2. Bending diagrams.
3. Prepare Shop Drawings in accordance with ACI 315 and 315R.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver reinforcement free of loose rust, scale, paint, oil and structural defects, and store on the site so as to maintain that condition.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. All concrete reinforcement and accessories shall be new, free from rust, scale, paint, oil and structural defects.

2. Reinforcement shall be the sizes indicated on the Drawings.

B. Reinforcing bars:

1. ASTM A 615.
2. Yield stress: Fy = 60,000 psi.

C. Welded wire fabric:

1. ASTM A 185.
2. Yield stress: Fy = 65,000 psi.
3. Plain, cold drawn, electrically welded fabric.

D. Accessories:

1. Chairs, bolsters, anchors, spacers, stirrups, ties and all other devices as required for spacing and fastening reinforcement in place shall conform to CRSI Manual of Standard Practice.

2. At exposed underside of concrete, use plastic-tipped chairs and bolsters.

2.2 FABRICATION

A. General:

1. Fabricate reinforcement to the dimensions indicated on the Drawings and the reviewed Shop Drawings.

2. Tolerances: As indicated in ACI 117.

3. Bundle and tag reinforcement with suitable identification to permit checking, sorting and placing.

4. Welding:

   a. Not permitted, unless specifically indicated on the Drawings.
   b. When permitted, comply with AWS D1.4.

B. Hooks:

1. Bend hooks in accordance with ACI 318. Extension on 90 degree hook shall satisfy the requirements of a standard hook unless indicated longer on the Drawings.

2. Cold bend bars in such a way that will not damage the reinforcement.

C. Unacceptable materials:

1. Reinforcement with any of the following defects will not be permitted in the Work:

   a. Bar lengths, depths and bends exceeding specified fabrication tolerances.
   b. Bends or kinks not indicated on Drawings or final Shop Drawings.
   c. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.1 PLACEMENT

A. Place concrete reinforcement in accordance with:

1. Shop Drawings reviewed by Engineer.
2. CRSI Placing Reinforcing Bars.
3. ACI 117.

B. Clearance:

1. Preserve clear space between bars of not less than 1 times the normal diameter of round bars.

2. In no case let the clear distance be less than 1-inch or less than 1-1/3 times the maximum size of aggregate.

3. In the absence of specific cover requirements on the Drawings, provide the following minimum concrete cover for reinforcement:

   a. Cast against and permanently exposed to earth: 3 inches.

b. Exposed to earth, weather or water:

1) No. 6 through No. 18 bars: 2 inches.
2) No. 5 bars, 5/8-inch wire and smaller: 1-1/2 inches.

C. Splices:

1. Comply with ACI 318 and this section.

2. In the absence of specific lap requirements on the Drawings, lap in accordance with ACI 318, Class B.

D. Corner bars:

1. Provide corner bars for horizontal wall steel.

2. In the absence of specific lap requirements on the Drawings, lap in accordance with ACI 318, Class B.

E. Field cutting and bending: Permitted only under special conditions approved by Engineer.

F. Field welding:

1. In accordance with AWS D1.4.
2. Only when specifically indicated on the Drawings.

G. Welded wire fabric:

1. Block up, lap and tie welded wire fabric reinforcement.
2. Lap welded steel fabric 6 inches at sides and ends.

3.2 FIELD QUALITY CONTROL

A. Notification:

1. Notify Engineer when reinforcing is in place so Engineer may review the reinforcement placement.

2. Provide a minimum of 24 hours notice prior to placement of concrete.

END OF SECTION 032015

SECTION 033020 – CAST-IN-PLACE CONCRETE FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the furnishing and placement of cast-in-place concrete and accessories.

B. Related sections include the following:

1. Division 03 Section "Concrete Formwork for Steam Utility Distribution."
2. Division 03 Section "Concrete Reinforcement for Steam Utility Distribution."
3. Division 03 Section "Concrete Accessories for Steam Utility Distribution."

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with the following:

1. ASTM Standards, Specifications, Methods, Test Methods and Classifications:

a. C33 - Specification for Concrete Aggregates.

b. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.

c. C94 - Specification for Ready-Mixed Concrete.

d. C136 - Sieve Analysis of Fine and Coarse Aggregates.

e. C150 - Specification for Portland Cement.

f. C260 - Specification for Air-Entraining Admixtures for Concrete.

g. C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

h. C494 - Specification for Chemical Admixtures for Concrete.

i. C595 - Blended Hydraulic Cements.

j. C618 - Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

k. C939 - Test Method for Flow of Grout for Preplaced - Aggregate Concrete.

l. C1107 - Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).

2. ACI - American Concrete Institute:

a. 117 - Standard Tolerances for Concrete Construction and Materials.

b. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

c. 301 - Specifications for Structural Concrete for Buildings.

d. 302.1R - Guide for Concrete Floor and Slab Construction.

e. 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

f. 304.2R - Placing Concrete by Pumping Methods.

g. 305R - Hot Weather Concreting.

h. 306R - Cold Weather Concreting.

i. 309R - Guide for Consolidation of Concrete.

j. 318 - Building Code Requirements for Reinforced Concrete.

k. 503.2 - Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive.

3. MDOT - Standard Specifications for Construction.

4. U.S. Army Corps of Engineers: CRD C621 - Grout.

1.4 SUBMITTALS

A. Manufacturer's literature for concrete mix designs to include:

1. General: Allow for 28-day testing of trial mixes in the Project's schedule, if trial mixes are required.

2. Mix design content:

a. Dry weights of cement.
b. Saturated surface - dried weights of fine and course aggregates.
c. Quantities, type and name of all mix design contents.
d. Weight of water.
e. Submit to Engineer and obtain approval prior to placing concrete.

3. Submit product information on all components of mix design.

4. Curing agents: Submit manufacturer's data certifying application rate required for each type of curing agent to be used.

B. Test reports:

1. Submit reports of concrete, compression, yield, air content and slump tests.

2. Furnish copies to Engineer and Contractor.

C. Submit product information on all materials listed in this section which are proposed to be used.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Fabrication and installation personnel:

a. Trained and experienced in the fabrication and installation of the materials and equipment.

b. Knowledgeable of the design and the reviewed Shop Drawings.

B. Testing of concrete:

1. Point of sampling and the method of securing the Samples:

a. Determined by the independent testing laboratory.
b. In accordance with ASTM C 172.

2. Slump tests:

a. Perform slump tests in accordance with ASTM C 143.

b. Perform 1 slump test on the job for each 10 cubic yards of concrete, minimum 1 test per day.

c. Perform more slump tests if deemed necessary by Owner.

3. Perform 1 air-entraining test in accordance with ASTM C 231 or C 173 for each truckload or every 10 yards of concrete placed, whichever is more frequent.

4. Test the concrete unit weight in accordance with ASTM C 138 or C 567, as applicable.

5. Test the air content of each set of concrete cylinders.

6. Concrete cylinder testing:

    a. In accordance with ASTM C 31 and C 39.

    b. Take concrete cylinder Samples as follows:

        1) Once each day a given class of concrete is placed, nor less than

        2) Once for each 150 cubic yards (or fraction thereof) of each class of concrete placed each day, nor less than

        3) Once for each 5000 square feet of slab or wall surface area placed each day.

    c. Concrete cylinder Sample shall consist of 6 standard 6-inch cylinders.

    d. Handle cylinders carefully.

    e. Onsite storage:

        1) 12 hours, minimum, 48 hours maximum.

        2) At a temperature range of 60 to 80 degrees F and in a moist environment.

        3) Shielded from direct sunlight and radiant heat.

        4) Contractor shall construct heated enclosure if conditions require.

    f. Laboratory curing: For duration of curing after onsite storage.

    g. Test 2 of the cylinders at 7 days, 2 of the cylinders at 14 days, and 2 of the cylinders at 28 days.

    h. Acceptance and evaluation of the concrete shall be based on ACI 301.

C. Crystalline Waterproofing Additive:

1. Manufacturer Qualifications: Manufacturer to be ISO 9001 registered and to have no less than 10 years experience in manufacturing the crystalline waterproofing additive for the required work. Manufacturer must be capable of providing field service representation during construction phase. Manufacturers that cannot provide the performance test data specified herein will not be considered for the Project.

2. Applicator: Installer of crystalline waterproofing additive shall be approved by the Manufacturer or Manufacturer's representative in writing.

3. Pre-installation Conference: Prior to installation of waterproofing, conduct meeting with Architect/Engineer, Owner's representative, applicator (concrete Supplier), concrete placer and waterproofing Manufacturer's representative to verify and review the following:

   a. Project requirements for waterproofing as set out in Contract Document.

   b. Manufacturer's product data, including application instructions.

4. Technical Consultation: The waterproofing Manufacturer's representative shall provide technical consultation on waterproofing application.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. Portland cement, ASTM C150, Type I.

2. Cements complying with ASTM C595, Type 1L or Type 1L(10) are permitted as a substitution for ASTM C150, Type 1 cement.

3. Do not use different types of cement, different manufacturers of cement, or different degrees of fineness.

B. High early cement: Portland cement, ASTM C150, Type III, at Contractor's option.

C. Fly ash:

1. ASTM C618, Type F.

2. At Contractor’s option.

3. Allowable amount: 25% of total cementitious materials, by weight, maximum, unless specified otherwise in Article 2.2.

D. Ground-Granulated Blast Furnace (GGBF) Slag:

1. ASTM C989, Grade 120.

2. Use at Contractor’s option, at a substitution rate of up to 25% of the total cementitious products content of the mix design; however, maintain a minimum of 330 pounds of Portland cement in concretes which may be subjected to freeze thaw cycles.

E. Aggregates:

1. Grade aggregates according to procedures of ASTM C136.
2. Coarse aggregate: ASTM C33-5S, Number 67 (3/4-inch) or MDOT 17A.
3. Fine aggregate: ASTM C33 or MDOT 2NS.

F. Water: Clean, fresh, and potable.

G. Admixtures:

1. Chlorides:

a. No admixture shall contain more than 0.1% water soluble chloride ions by mass of cementitious material.

b. No admixture shall contain calcium chloride.

2. Air-entraining:

a. Comply with ASTM C260.

b. Daravair series or Darex series, by GCP Applied Technologies; MasterAir, by Master Builders; or equal.

3. Mid-range water reducer:

a. Comply with ASTM C494, Type A.

b. Daracem 55 or Daracem 65, by GCP Applied Technologies; Polyheed Series by Master Builders; or equal.

4. Water reducing and retarding:

a. At Contractor's option, when included in reviewed mix designs.

b. Comply with ASTM C494, Type D.

c. Daratard 17 or WRDA35 by GCP Applied Technologies; MasterPozzolith 200 by Master Builders; or equal.

5. Water reducing and accelerating:

a. At Contractor's option, when included in reviewed mix designs.

b. Comply with ASTM C494, Type E.

c. Daraccel by GCP Applied Technologies; Masterset FP 20 by Master Builders; or equal.

H. Curing agents:

1. Curing agents shall comply with ASTM C309.

2. Provide approved products by Symons Corporation, W.R. Meadows, L & M Chemical, Master Builders, or Dayton-Superior.

3. Manufacturer shall guarantee that Manufacturer's material is compatible with the intended application.

4. Maximum V.O.C. limit: 350 gm/l.

5. No wax based compounds allowed.

6. Compounds:

   a. Curing:
      1) 1100 Clear by W.R. Meadows.
      2) Rez Cure (J-11-W) by Dayton Superior.
      3) Resi-Chem Clear Cure by Symons.
      4) Masterkure by Master Builders.
      5) L & M Cure by L & M Chemical.

I. Epoxy bonding agent: Concressive Standard Liquid or Standard Paste, as applicable, Master Builders; or equal.

J. Crystalline Waterproofing Additive:

1. Acceptable Manufacturer:

   Xypex Chemical Corporation
   13731 Mayfield Place, Richmond, B.C., Canada V6V 2G9
   Telephone: 800-961-4477 or 604-273-5265
   Fax: 604-270-0451
   Email: info@xypex.com
   Website: www.xypex.com

2. Proprietary Products: Xypex crystalline waterproofing materials as follows:

   a. Xypex Admix C-500.
   b. Xypex Admix C-1000.
   c. Xypex Admix C-2000.

3. Source Quality: Obtain proprietary crystalline waterproofing products from a single manufacturer.

2.2 MIXES

A. General proportioning:

1. Proportions of materials for concrete shall be in accordance with ACI 211.1, in order to produce concrete with the specified compressive strength, good placability and durability, and other specified properties.

2. Concrete mixes as noted below shall receive a mid range water-reducing admixture added at the ready mix plant.

3. To ensure concrete of adequate strength, concrete proportions shall be selected and documented in accordance with ACI-318. This will determine the required average compressive strength (f'cr) of the concrete as supplied by the concrete production facility. The procedure is described below:

    a. The required average compressive strength (f'cr) of the concrete shall exceed the specified compressive strength (f'c). The amount by which the required average compressive strength (f'cr) must exceed the specified compressive strength (f'c) shall be determined by 1 of the following:

        1) Where the concrete production facility has 15 or more consecutive tests for concrete composed of similar materials and with specified strengths within 1,000 psi of that specified for proposed works, a standard deviation shall be calculated. This standard deviation is a measure of the variability of strength produced by the production facility for concrete of similar proportions. The required average compressive strength (f'cr) shall be calculated using this standard deviation along with appropriate formulas as given in ACI-318.

        2) Where the concrete production facility does not have test records meeting the required criteria, the required average compressive strength (f'cr) must exceed specified compressive strength (f'c) by a minimum of 1,200 psi.

    b. Documentation that the proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength (f'cr) shall consist of 1 of the following

        1) Where the concrete production facility has 10 or more field strength tests for concrete produced with similar materials and under similar conditions, these tests may be used to demonstrate that the proposed concrete proportions will produce the required average compressive strength (f'cr).

        2) Where the concrete production facility does not have test records meeting the Mix Design Criteria, concrete proportions shall be established based on trial mixtures in accordance with ACI 318, Paragraph 5.3.3.2.

    c. Provide mix design, test records, calculations and other documentation to Engineer at least 14 days prior to placement. Also state type of mixing to be used as listed in Item 10, ASTM C94.

    d. Should trial mixes be required, no concrete shall be placed until results from the 28-day tests have been reviewed and approved by Engineer.

B. Fly ash:

1. If Contractor chooses to use fly ash in concrete mixes:

   a. Proposed mix design shall specifically identify amount and type of fly ash.

   b. Field strength test data submitted with proposed design shall be for concrete mixes that included similar amount and types of fly ash.

C. Mix Design Criteria:

1. Ratio of weight of fine aggregate to weight of coarse aggregate shall not be less than 0.50.

2. Mid range water-reducing admixture (MRWR): Approximately 3 to 12 ounces per 100 pounds of cement, to achieve specified slump.

3. Refer to table below for specific proportioning.

Mix Design	Use	Minimum* Cementitious Content (94 lb. sack) (1)	Fly Ash Content	Entrained Air (percent)	Maximum w/c (2) Ratio	Specified Maximum Coarse Agg.	Compress Strength (PSI)	Slump (Inches) Before Adding Water Reducer	Slump (Inches) After Adding Water Reducer	Water Reducing Admixture Type	Crystalline Waterproofing Additive
1	Structural Concrete	6	Optional	6 ± 1-1/2	0.45	3/4"	4,000	1-4	4-6	Optional MRWR	2% to 3%

Notes:

(1) Use a higher cement content if required to achieve the required w/c ratio and strengths.
(2) w/c - Water to cementitious products ratio. All fly ash plus GGBF slag plus all cement shall be included in w/c ratio calculation.
(3) Slabs which slope more than 1/4-inch per foot shall have a slump after adding water reducer of 2 to 5 inches.
(4) The compressive strength specified here and on the Drawings is the actual required specified compressive design strength (f'_c) at 28 days (unless noted otherwise) for the concrete structures on this Project, and is not be considered the target strength (f'_{cr}) which the concrete Supplier is required to achieve.
(5) Ratio of weight of fine aggregate to weight of coarse aggregate shall not be less than 0.50.
(6) The amount of mid range water-reducing admixture (MRWR) added shall be approximately 3 to 12 ounces per 100 pounds of cement, to achieve specified slump.

D. Climatic conditions: Concrete mix design shall be adjusted for climatic conditions.

2.3 SOURCE QUALITY CONTROL

A. Production and delivery:

1. Ready mixed concrete shall be batched, mixed and transported in accordance with ASTM C94.

2. Ready-mix delivery tickets:

a. Furnish with each batch of concrete before unloading at the site, a delivery ticket on which is printed, stamped or written the following information:

1) Name of ready-mix batch plant.
2) Serial number of ticket.
3) Date and truck number.
4) Name of Contractor.
5) Job name and location.
6) Specific class or designation of concrete.
7) Amount of concrete (cubic yards).
8) Time loaded or of first mixing of cement and aggregates.
9) Type, name and amount of admixture.
10) Type, brand and amount of cement.
11) Total water content by producer (or water-cement ratio).
12) Maximum size of aggregate.
13) Weights of fine and course aggregates.

3. Concrete delivered in an outdoor temperature lower than 40 degrees F shall arrive at the site of the Work having a temperature of not less than 60 degrees F and not greater than 90 degrees F unless otherwise specified or permitted by the Engineer.

4. Discharge of the concrete shall be completed within 1-1/2 hours after introduction of mixing water to the cement or 1 hour after arriving at the Site, whichever is sooner.

PART 3 - EXECUTION

3.1 PLACEMENT

A. General: Place concrete in accordance with ACI 304R and ACI 304.2R.

B. Preplacement inspection:

1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel and items to be embedded or cast-in.

2. Notify other trades to permit the installation of their work; cooperate with other trades in setting such work, as required.

3. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.

4. Notify Engineer 24 hours in advance of placing.

C. Handling:

1. Handle concrete from mixer to place of final deposit in carts, buggies, conveyors, pumps or crane buckets.

2. Do not deliver concrete by a method with a free fall of more than 3 feet.

3. Crane buckets shall have a reinforced rubber chute which shall extend into formwork to minimize free fall of concrete and to eliminate separation of materials.

4. Take every possible precaution to prevent separation or loss of ingredients while transporting concrete.

5. Do not place concrete into standing water (unless approved tremie procedures are followed), and do not displace standing water with fresh concrete.

D. Method and rate:

1. Deposit concrete in horizontal layers in walls to avoid flowing along the forms.

2. Horizontal layers shall not exceed 18 inches in thickness and placed in a manner to avoid inclined construction joints.

3. Carry on placement at such a rate that concrete surfaces not yet to grade shall not have reached their initial set before additional concrete is placed.

E. Compaction:

1. Mechanically vibrate concrete to thoroughly embed reinforcement and fixtures.

2. Apply mechanical vibration directly to concrete.

3. Apply vibration at point of deposit and in area of freshly placed concrete.

4. Vibrations shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be long enough to cause segregation of mix.

5. Withdraw vibrator at the rate of 1-1/2 inches per second.

6. Use vibrators designed to operate with vibratory element submerged in concrete, maintaining a speed of not less than 6,000 impulses per minute.

7. Comply with ACI 309R.

8. Do not use vibrators to transport concrete inside of forms.

9. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine.

10. Avoid inserting vibrators into lower layers of concrete that have begun to set by scheduling placement of concrete layers and concrete delivery.

F. Retempering:

1. Do not add water to the concrete once it has left the redimix plant.

2. Concrete which has stood for 60 minutes is unacceptable and shall be immediately removed from the premises.

G. Site redosing with water reducer:

1. One redosing of batched concrete at the Project site may be permitted only under the following conditions:

a. Redosing has been approved in advance by Engineer.

b. Equipment is on-site to permit accurate measurable dispensing.

c. Adequate supply of water reducer in on-site.

d. Engineer or independent testing laboratory witnesses the addition of water reducer, verifies the quantity, and witnesses the proper truck mixing of the redosed concrete.

H. Cold-weather concrete operations:

1. Comply with the recommendations of ACI 306R.

2. Recommended protective measures:

a. Heating materials.
b. Providing insulating blankets and windbreaks.
c. Use heated enclosures.

3. Advise Engineer of planned protective measures.

4. Straw or similar materials shall not be allowed.

5. Do not use frozen materials or materials containing ice or snow.

6. Do not place concrete on frozen subgrade.

I. Hot-weather concrete operations:

1. Comply with the recommendations of ACI 305R.

2. Recommended protective measures:

a. Cooling materials.

b. Concrete placement during cooler hours of the day.

c. Providing shading and windbreaks.

3. Advise Engineer of planned protective measures.

3.2 SURFACE TREATMENT

A. Wall finishes: Refer to Division 03 Section "Concrete Formwork for Steam Utility Distribution" for formwork facing materials and required finishes.

B. Patching:

1. Patch poor joints, voids greater than 1/4-inch, honeycomb, defective areas and tie holes immediately after stripping forms.

2. The finished patch shall be acceptable to Engineer and reasonably match the adjacent wall construction or the defective wall shall be replaced.

3. Suggested concrete mix mortar patching method:

a. Patch material shall consist of mortar with the same proportions as the concrete to be patched except omit coarse aggregate.

b. Mix different proportions of gray and white cement until exact color of concrete is obtained.

c. Bond patch material to concrete with epoxy bonding agent in accordance with manufacturer's instructions and recommendations.

d. The use of an epoxy bonding agent for bonding plastic concrete to hardened concrete shall conform to all requirements of ACI 503.2, except as modified by the requirements of this project specification.

e. Remove all latence and foreign materials from areas to be patched by means of sandblasting.

C. Troweling floors:

1. Provide monolithic troweled finish.

2. Vibratory screeding is required on concrete slabs.

3. Use highway straight edge to eliminate high and low spots.

4. After screeding and as soon as concrete has set sufficiently, float surface with compactor power floats, then steel trowel surface, burnishing to smooth, hard, dense finish free from trowel marks, blemishes and irregularities.

D. Floor finish tolerances:

1. In accordance with ACI 117 and 302.1R.

2. Interior building floors shall have a maximum sag of 1/8-inch under a 10-foot straight edge.

3. No "bird bath" allowed on sloping floor slabs.

E. Curing agents:

1. Curing agents shall be immediately applied to walls and slabs.

2. Compound shall be rolled or sprayed on in accordance with manufacturer's instruction. Each application shall be applied at the rate in gallons per square foot and number of coats required to meet ASTM C309.

3.3 PROTECTION

A. Keep freshly placed concrete from damage due to low temperatures when the mean daily temperature is below 40 degrees F (4.5 degrees C) in accordance with ACI 306R.

3.4 JOINTS AND EMBEDDED ITEMS

A. Comply with ACI 318-6.3, 6.4 and ACI 301 Section 6.

B. Avoid horizontal construction joints in walls.

C. Tunnel joints:

1. Tunnels shall have construction joints as indicated on the Drawings. Where no specific indication is given, limit joints to 25 feet spacing.

2. Vaults shall have construction joints only as indicated on the Drawings.

D. Construct a keyway at construction joints in concrete. In reinforced concrete, provide lap of reinforcing steel at construction joints.

E. Contractor shall be responsible for controlling the proper placing of embedded pipe, conduit and other fixtures. ACI 318, Section 20.7, shall apply to cases of embedded fixtures.

F. Anchor rods shall be clean and free of oil, grease and dirt prior to installation.

3.5 MISCELLANEOUS

A. Chamfer: Chamfer exposed concrete edges 3/4-inch x 3/4-inch unless otherwise indicated on the Drawings.

B. Miscellaneous items: Perform concrete work for mechanical and electrical trades including but not limited to vaults, valve and meter pits, light pole bases and machine bases.

END OF SECTION 033020

SECTION 336010 – UTILITY DISTRIBUTION GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, materials, and equipment as necessary to complete work as indicated on the drawings, as specified herein.

B. Steam Utility Distribution: As used in these Specifications, the steam utility distribution system includes low pressure steam, high pressure steam, pumped condensate and vacuum condensate return piping external to buildings and inside of buildings as follows:
   1. High pressure steam up to the pressure reducing valve.
   2. Condensate return from the pump discharge connection.

C. Work Included:

   1. Demolition of existing steam and condensate pipe valves and fittings from existing vault and tunnel to point of reconnection as indicated on Drawings.

   2. New work consisting of new steam and condensate pipe valves and fittings from existing vault through new tunnel and new vaults, connecting to existing vault, tunnel, building and as indicated on Drawings.

D. Work Not Included:

   1. Motor starters shall be provided and installed by the electrical contractor.

E. Excavating and Backfilling:

   1. Excavating and backfilling shall be done in accordance with Division 31 Section “Earthwork.”

F. Materials To Be Returned To The Owner:

   1. Coordinate with Owner for delivery of the following items removed from the site and not reused in the work to Owner’s Physical Plant storage yard:

      a. Butterfly and gate valves on steam and condensate piping.
      b. Expansion joints on steam and condensate piping.

1.2 REFERENCES

A. Codes and standards are described in the Specification by reference to various associations.

   1. ACGIH - American Conference of Governmental Industrial Hygienists.

   2. AGA - American Gas Association.

3. ANSI – American National Standards Institute.
4. AMCA – Air Moving and Conditioning Association.
5. ASHRAE - American Society of Heating, Refrigeration and Air-Conditioning Engineers.
6. ASME - American Society of Mechanical Engineers.
7. ASSE - American Society of Sanitary Engineering.
8. ASTM - American Society for Testing Materials.
9. ARI - Air-Conditioning and Refrigeration Institute.
10. AWWA - American Water Works Association.
11. BOCA - Building Officials and Code Administration.
12. CTI - Cooling Tower Institute.
13. ICC - International Code Council.
14. LEED™ - Leadership in Energy & Environmental Design.
15. MICA - Midwest Insulation Contractors Association.
16. MMC - Michigan Mechanical Code.
17. MPC-- Michigan Plumbing Code.
18. MSS - Manufacturers Standardization Society.
19. NEBB - National Environmental Balancing Bureau.
20. NEMA - National Electrical Manufacturer’s Association.
21. NFPA - National Fire Protection Association.
22. NSF - National Sanitation Foundation.
23. OSHA - Occupation Safety and Health Act.
24. PDI - Plumbing and Drainage Institute.
25. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.
26. UL - Underwriter’s Laboratories, Inc.

1.3 SUBMITTALS

A. Shop Drawings: Submit for major equipment including, but not limited to the items listed in Division 33 sections.

B. Coordination and Layout Drawings: Submit coordination and layout drawings for systems including, but not limited to, those listed in Division 33 sections, as necessary for coordination between trades and to ensure adequate access to installed components.

C. Operating and Maintenance Manuals:

1. When the project is substantially complete and before the project is taken over by MSU for maintenance purposes, the Contractor shall be required to provide the Engineer with three (3) complete sets of written instructions covering the proper operation and maintenance requirements of all equipment furnished under these specifications.

2. The manuals shall consist of an indexed loose-leaf binder containing the manufacturer's installation, operating, maintenance, lubrication and repair parts manual for each system component; approved shop drawings including equipment performance data and pump and fan performance curves, and test reports. Small scale drawings will be furnished by the Project Representative for this purpose if desired. Should clarification be required on any of the above requirements, sample copies of acceptable manuals are available for inspection. All outsize sheets shall be recopied to provide uniformity of size.

D. Permits and Inspections: Provide as described in this section.

E. Warranties: Submit written special warranty as specified in this Section. Include contact information, description of coverage, and start date for each special warranty.

1.4 QUALITY ASSURANCE

A. Permits and Inspections

1. Obtain and pay for permits (temporary and permanent), fees, and inspections as required by applicable laws or ordinances. Post such permits and inspection certificates in a prominent place adjacent to the work.

2. Deliver certificates of final inspection or approval to the Project Representative.

3. Do not cover concealed work until final inspection has been made and approval certificates obtained.

B. Codes, Regulations and Standards:

1. Refer to Division 01 General Requirements for Codes and Regulations that apply.

2. Following codes and standards shall be used as minimum requirements. Where codes are contradictory, follow the most stringent. Where the Specifications or Drawings call for an installation that exceeds and does not violate the Code requirements, the Specifications and Drawings shall be followed.

    a. Michigan Mechanical Code, 2009.
    b. Michigan Plumbing Code, 2009.
    c. MI.O.S.H.A.
    d. Michigan Uniform Energy Code.
    e. Michigan Fire Safety Rules.
    f. Michigan Barrier Free Design.
    g. ADA Public Law 101-336.
    h. ASHRAE Standards.
    i. LEED™ NC 3.0.
    j. NFPA Standards.
    k. SMACNA Standards.
    l. Michigan Boiler Code.

1.5 WARRANTY

A. In the event that part of the work or equipment fails (abuse and causes beyond control of the Contractor excepted), within this period of warranty, it shall be replaced by the Contractor at no cost to the Owner.

1.6 SYSTEM START-UP

A. Activation of the steam and condensate systems for testing will be allowed only after the construction is substantially complete, or by permission of the Project Representative.

B. Activation and shutdown of University utility systems shall be conducted by MSU personnel only. Coordinate shutdowns 10 days in advance with Project Representative.

1.7 MAINTENANCE

A. Contractor shall be responsible for maintenance of equipment and systems installed until final acceptance by Owner.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Character of Work: The installation shall be executed in a workmanlike manner and shall present a neat mechanical appearance when completed.

B. Laying Out Work:

1. Lay out piping and equipment in accordance with the Contract Documents and the manufacturer's recommended practice including provision of adequate space for maintenance. Review layout with the Project Representative prior to installation.

2. Review Drawings to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, notify the Project Representative before proceeding with installation.

3. If directed by the Project Representative, make reasonable modifications in the layout as required to permit proper execution of the work and to prevent conflict with work of other trades.

4. Work shall be installed so as to be readily accessible for operation, maintenance and repair. Minor deviations from Drawings may be made to accomplish this. Changes shall not be made without approval of the Project Representative.

C. Connection to Existing Systems:

1. Connections to existing system shall be arranged in advance and shall be made at the convenience of the Owner.

2. Existing water systems that must be drained for work shall be refilled and purged of air at the end of the Project.

D. Accessibility:

1. Coordinate the exact location with the work of other trades.

3.2 FIELD QUALITY CONTROL

A. Site Tests:

1. Furnish labor and equipment necessary for the completion of tests called for in these Specifications.

2. Arrange with authorities to complete the tests without unnecessary delays so that the work may progress as rapidly as possible. Notify the Project Representative in advance of tests, at least 72 hours before starting tests.

3. Tests shall be repeated after defects disclosed thereby have been made good or the work replaced, if in the judgment of the Project Representative, it is deemed necessary.

4. Test Equipment: Instrumentation shall be provided as necessary and appropriate to perform the work. The instrument shall be factory calibrated, and shall be used with the factory-determined application factors. When reasonable doubt of accuracy exists, recalibration of instrumentation shall be performed as requested by the Project Representative.

3.3 DEMONSTRATION

A. The Contractor shall demonstrate and give verbal instructions to the Owner's authorized personnel on the operation and maintenance of the complete steam and condensate systems in this Project.

END OF SECTION 336010

SECTION 336017 – INSULATION FOR UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the Drawings and as specified herein.

B. This section includes the furnishing and installation of insulation of steam and condensate piping for steam and condensate utility distribution.

C. Related sections include the following:

1. Division 33 Section "Utility Distribution General Requirements."
2. Division 33 Section "Steam and Condensate Utility Distribution."

1.3 REFERENCES

A. MICA, National Commercial & Industrial Insulation Standards.

B. ASHRAE/IES 90.1-2007, Energy Efficient Design Of New Buildings Except Low-Rise Residential Buildings.

C. ASTM E84, Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Product Data for each type of insulation identifying k value, thickness, and accessories.

B. Drawing and Product Data for expansion joint insulation blankets.

1.5 QUALITY ASSURANCE

A. Insulation shall have a flame-spread rating of 25 or less and smoke-developed rating of 50 or less as tested by ASTM E84.

1.6 SEQUENCING AND SCHEDULING

A. No insulation shall be applied before required tests have been run. Schedule insulation application after system testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Owens-Corning, Johns-Manville, Schulle, Knauf, Armstrong, IMCOA, Dow Chemical, Pittsburgh Corning, Aspen Aerogels, Inc.; or approved equal.

2.2 FIBER GLASS PIPE INSULATION

A. Fiber glass pipe insulation shall have a thermal conductivity k of 0.23 BTU-in/hr-sq. ft.-degree F or less at 75 degree F mean temperature, a reinforced vapor retarder jacket, and a factory-applied longitudinal adhesive closure system. Section joints shall be sealed with butt strips. Maximum jacket permeance shall be 0.02 perm.

B. Equal to Owens-Corning "Fiberglas SSL II" or Johns Manville "Micro-Lok AP-T Plus."

2.3 CALCIUM SILICATE PIPE AND BLOCK INSULATION

A. Calcium silicate pipe and block insulation shall be asbestos-free, molded, high temperature insulation composed of hydrous calcium silicate with a density of 14.5 lb./cu. ft., and thermal conductivity k of 0.41 BTU-in/hr-sq. ft.-F or less at 200 degrees F mean temperature.

B. Equal to Johns Manville "Thermo-12 Gold".

2.4 RIGID MOLDED CELLULAR GLASS

A. 8 lbs./cu. ft. minimum density.

B. k factor of 0.33 maximum at 75 degrees F.

C. 0.00 water vapor permeability.

D. 900 degree F service temperature.

E. Laminated aluminum foil/vinyl/kraft paper jacketing except where aluminum laminated jacketing is specified.

F. Pittsburgh Corning “Foamglas;” or equal.

2.5 POLYURETHANE INSULATION

A. A continuously molded foam insulation having:

1. Nominal density of 2.0 lbs./cu. ft.
2. k factor of 0.14 at 75 degrees F mean.
3. Flame spread rating of 25 or less when tested in accordance with ASTM E84.
4. Closed cell content of 90% to 95%.
5. Complies with ASTM C591.

2.6 POLYISOCYANURATE INSULATION

A. High temperature polyisocyanurate insulation shall have the following properties:

1. Minimum Density: 2.0 pcf in accordance with ASTM D1622.
2. Closed Cell Content: 90% in accordance with ASTM D2856.
3. Compressive Strength: 30 psi in accordance with ASTM D1621.
4. k Factor:

a. Initial at 75 Degrees F Mean Temperature: 0.113.
b. At 200 Degrees F Mean Temperature: 0.235.
c. Aged at 400 Degrees F for 28 Days: 0.220.
d. At 400 Degrees F Service Temperature and 75 degrees F Ambient: 0.240.

B. Dimensional Stability: % Change in accordance with ASTM 2126:

1. 400 Degrees F Exposure of 2-Inch Cube Foam Sample:

a. 1 day plus 1.3% length, plus 0.1% volume.
b. 7 day plus 2.3% length, minus 2.3% volume.

2. 450 Degrees F Exposure of 2-Inch Cube Foam Sample:

a. 1 day plus 10.31% length, plus 14.6% volume.
b. 7 day plus 7.1% length, plus 1.5% volume.

C. Insulation must be rated for exposure to a continuous temperature of 400 degrees F and capable of handling intermittent temperature spikes to 450 degrees F for 8 to 12 hours.

2.7 MINERAL-FIBER INSULATION

A. Preformed Pipe Insulation:

1. Type I, 850 Degrees F (454 Degrees C) Materials:

a. Mineral or glass fibers bonded with a thermosetting resin.
b. Comply with ASTM C547, Type I, Grade A, without factory applied jacket.

2. Johns Manville "Micro-Lok;" or equal.

B. Pipe and Tank Insulation:

1. Mineral or glass fibers bonded with a thermosetting resin.

2. Semirigid board material complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB.

3. Nominal density is 2.5 lb./cu. ft. (40 kg/cu. M) or more.

4. Thermal conductivity (k-value) at 100 degrees F (55 degrees C) is 0.29 BTU x in./h x sq. ft. x degrees F (0.042 W/m x K) or less.

5. Johns Manville; MicroFlex; or equal.

2.8 SILICA AEROGEL INSULATION

A. High temperature blanket formed of silica aerogel reinforced with non-woven glass fiber.

B. Silica aerogel insulation shall have following properties:

1. Minimum Density: 11.0 pcf.

2. Compressive strength: 26.6 psi at 25% strain in accordance with ASTM D165.

3. K Factor:

a. Initial at 32 Degrees F Mean Temperature: 0.14.

b. At 212 Degrees F Mean Temperature: 0.16.

c. At 392 Degrees F Mean Temperature: 0.19.

C. Dimensional Stability: % Change in accordance with ASTM C 356:

1. 1,200 Degrees F Exposure: 1.3% maximum.

D. Insulation must be rated for exposure to intermittent temperature spikes to 1,200 F for 8 to 12 hours.

E. Water resistant.

F. Pyrogel XTE as manufactured by Aspen Aerogels, Inc.; or approved equal.

2.9 JACKETS

A. Aluminum jackets shall be field or factory applied, sealed, and made of 0.016-inch thick sheet, smooth finish, with longitudinal slip joints and 2-inch laps, die shaped fitting covers with factory attached protective liner.

2.10 INSULATION INSERTS

A. Insulation inserts shall be made of calcium silicate treated with water repellant.

B. Inserts shall be preformed for the pipe size, same thickness as adjoining pipe insulation, same length as shield, and 180 degree-minimum segments.

C. Insulation inserts shall not be less than the following lengths:

2-1/2-inch pipe size and less	10 inches long
3-inch to 6-inch pipe size	12 inches long
8-inch to 10-inch pipe size	16 inches long
12-inch pipe size and larger	22 inches long

2.11 PIPING INSULATION SCHEDULE

MINIMUM INSULATION THICKNESS						
SERVICE TYPE	INSULATION MATERIAL *	*** VAPOR BARRIER REQ'D	NOMINAL PIPE DIAMETER (in Inches) 1 & less	1-1/4 to 1-1/2	2 to 4	5 & up
Steam	Fiber glass	No	3	3	3.5	4
	Cal. Silicate	No	4	4	4 **	4 **
	Silica Aerogel	No	-	-	-	2
Pumped Condensate	Fiber glass	No	2.5	2.5	2.5	3.5
	Cal. Silicate	No	3	3	4	4 **
	Silica Aerogel	No	-	-	-	1.6

* Calcium silicate insulation shall be used in all vault locations. Silica Aerogel shall be used for steam and condensate piping installed under the bridge.
** 5-inch used inside of buildings.
*** Aluminum jacketing required for steam and condensate utility distribution piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards except as modified or specified in these Specifications.

2. Verify that surfaces are clean, dry and free of foreign materials.

3. Continue insulation through penetrations.

B. Testing of Pipe:

1. Prior to installing insulation, inspect welds and pressure test pipe as required by other sections of this these Specifications.

2. Clean pipe of dirt, scale and foreign materials.

C. Installation of Piping Insulation in Tunnels, Vaults, and Buildings:

1. Verify that piping has been tested and cycled before applying insulation materials.

2. Sectional pipe covering shall be neatly and tightly applied with unbroken lengths and with the ends of the sections firmly butted together. Longitudinal joints shall be on the least conspicuous side of the pipe and slightly staggered. Fiberglass cloth or other coating shall be lapped over joints and well pasted or cemented down in a neat and inconspicuous manner.

3. The insulation on piping shall be extended through sleeves, anchor points and supports in order to produce a continuous application, and shall be installed to conform to a uniform diameter.

4. Fittings, flanges, end caps, etc. on lines, except where otherwise noted, shall be covered with insulated fitting covers. Thickness of insulation, jackets and finishes shall also match adjacent piping.

5. Secure calcium silicate pipe insulation with stainless steel bands.

6. Insulation for piping shall be continuous through hangers and supports.

7. Provide insulation inserts and insulation protection shields at hanger or support locations.

8. Valve bodies to the bonnet flange or union, drip legs, and pipes at anchor points shall be insulated. Terminate insulation into a finished end.

9. Steam traps shall not be insulated.

10. Terminate insulation into a finished end.

11. Provide aluminum jacketing on insulated piping.

12. Testing of Pipe:

    a. Prior to installing insulation, inspect welds and pressure test pipe as required by other sections of this these Specifications.

    b. Clean pipe of dirt, scale and foreign materials.

END OF SECTION 336017

SECTION 336023 – VALVES FOR UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the Drawings and as specified herein.

B. This section includes the furnishing and installation of general duty valves and cocks.

C. Related sections include the following:

1. Division 33 Section "Utility Distribution General Requirements."
2. Division 33 Section "Piping for Utility Distribution."

1.3 REFERENCES

A. ANSI/ASME B31.1 - Power Piping.

B. ANSI/ASME B31.9 - Building Services Piping.

C. ASTM B62 - Specification for Composite Bronze or Ounce Metal Castings.

D. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

E. MSS SP-67 - Butterfly Valves.

F. MSS SP-80 - Bronze Gate, Globes, Angle and Check Valves.

1.4 SUBMITTALS

A. Shop Drawings for a schedule of valves including type of service, sizes, and pressure/temperature ratings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Valves shall be suitable for temperature and pressure involved. Unless noted otherwise, valves shall be rated at not less than the following working pressures:

1. High pressure (above 15 psi) steam and condensate systems: 150 psi.

B. Accessory piping valves on steam lines shall be forged steel gate valves. Valves designated as welded shall be the butt or socket type, and those that are designated as screwed shall be threaded. Back welding of threaded steel valves will not be permitted. Valves indicated as threaded on one side and welded on the other, shall be welded steel valves with a threaded nipple welded to the side designated as threaded.

C. Acceptable Manufacturers:

1. Crane, Velan, Bonney Forge, Vogt, Edwards, Walworth, Powell, Jenkins, Stockham, or approved equal.

2.2 VALVE PACKING

A. Valve stems and other packed joints shall be tight under conditions of actual operation. Packing shall be John Crane, Garlock, or other approved metallic packing.

2.3 GATE VALVES

A. Gate valves, 2 inches in size and smaller Class 800 forged steel, shall be bolted bonnet, rising stem, solid wedge, socket or butt welded, ASTM A105 carbon steel to match Schedule 40 and 80 pipe end. Stems shall be 13% chromed stainless with steel handwheel. Equal to Vogt SW13111.

B. Gate valves, 2-inch in size and smaller Class 150, shall be rising stem, union bonnet, solid wedge, threaded or solder ends, and conform to MSS SP-80. Body, bonnet and wedge shall be of bronze ASTM B62. Stems shall be of silicone bronze ASTM B371, non-asbestos packing, and malleable iron handwheel. Valves shall be equal to Crane No. 431 UB, or Milwaukee 1151 or 1169. For use only on condensate discharge downstream of the trap.

C. Gate valves, 2-1/2 inches in size and larger Class 150, shall be manufactured in accordance with API600, OS&Y, bolted bonnet, welded ends, carbon steel body, solid wedge flexible disc, Type XU trimmed, and non-asbestos packing and gaskets. Body and bonnet shall conform to ASTM A216. Valves shall be equal to Crane No. 47-1/2.

D. All gate valves 20 inches or larger shall be provided with manual operators with bevel gear actuator with 4.0:1 reduction gearing. Minimum output torque shall be 2,000 ft/lbs.

2.4 CHECK VALVES

A. Swing check valves for sump pump application, 2 inches in size and smaller shall be Class 300, Y-pattern swing check, renewable disc, and threaded ends. Valves shall be equal to Stockam No. B375.

B. Spring loaded check valves for steam/condensate application, 2-inch in size and smaller, shall be all stainless steel in-line wafer check with spring assist. Valve shall be equal to "Durabla" SCV check valve.

C. Materials:

1. Carbon Steel body, buttweld style

2. Stainless steel shaft with stainless steel bearings.

3. Carbon steel disc.

4. Metal to metal seat with graphite seal and/or fully bi-directional on dead-end service.

D. Provide manual gear operator with high ratio for slow opening and handwheel.

E. Valves for steam applications shall be Zwick Tri-Con Series S or Adams MAK.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Shut-off Valves: Install at service connections and branches for isolation and repair, and as indicated on the Drawings. Valves shall be easily accessible from floor.

B. Steam valves 10 inches or larger shall be by-passed. Condensate valves need no bypass.

C. Bypass shall be installed in the field with forged steel gate valves. Bypass pipe and valve shall be 1-inch on steam valves 10 inches through 18 inches. Bypass and valve shall be 2-inch on steam valves 20 inches or larger.

D. Bleeders shall be installed on both sides of the main line valves on both the steam and condensate lines unless otherwise indicated on the Drawings. Bleeders shall be 1-inch in size. Valves on bleeders shall be placed so that they are easily accessible. An elbow and 2 nipples shall be placed on the valve outlet so as to direct the water and steam away from the tunnel walkway. Valves shall always be before any elbow.

E. All valves shall have their bonnets horizontal or above toward vertical.

END OF SECTION 336023

SECTION 336320 – STEAM AND CONDENSATE UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the Drawings and as specified herein.

B. This section includes the furnishing and installation of steam piping, steam condensate piping, and steam and condensate accessory piping.

1.3 REFERENCES

A. ASME B31.1, Power Piping.

B. ASME B31.9, Building Services Piping.

C. ASHRAE Systems and Equipment Handbook, Current Edition.

D. Michigan Boiler Code, Current Version.

1.4 SUBMITTALS

A. Shop Drawings to include: Pipe, piping specialties, and valves, in accordance with the requirements of other sections of this specification.

B. Test reports data for tests specified. Include torque test reports for flanges in accordance with the requirements of other sections of this specification.

C. Certification of installation from manufacturer's representative for pre-insulated buried piping.

1.5 QUALITY ASSURANCE

A. General:

1. The steam piping located in the tunnel is designed for an operating pressure of 150 psig which falls under the jurisdiction of the Michigan Boiler Division and the Boiler Act of 1965.

2. The Act was amended in 1995 which included a clarification of Rule 113 concerning high pressure piping. Steam piping under this rule includes any steam piping where the pressure is over 15 psig and must be installed or repaired in accordance with the ASME B31.1 Power Piping Code and the Rules of the Michigan Boiler Law and Rules.

3. The steam piping located in the tunnels is considered Non-Boiler External Piping under the ASME B31.1 Power Piping Code.

B. General Welding Quality Assurance:

1. Contractors working on these systems are required to be licensed by the State of Michigan Boiler Division.

2. Employers are responsible for qualifying Welding Procedure Specifications (WPS) that are intended to be used by personnel of that organization.

3. Each employer is responsible for qualifying the welders and welding operators employed by that organization and maintain a certificate of Welder/Welding Operator Performance Qualification for each welder under their employment.

4. The employer shall maintain records of the WPS and the welders or welding operators used by that organization and the identification symbol assigned to each welder and their performance qualification.

5. The employer shall use this identification symbol to identify the welds performed by a welder or welding operator by either:

a. Applying the symbol of the welder or welding operator to the joint in a manner specified by the organization.

b. Maintain weld map records identifying the joint with the welder or weld operator.

C. Examinations:

1. Examinations are to be performed by the fabricator, erector, or a party authorized by the Owner which include visual examinations and observations.

2. Visual examinations as defined are to be performed as necessary during the fabrication and erection of the piping components to provide verification that the design and WPS requirements are being met.

3. Visual examinations shall also be performed to verify that completed welds in pipe and piping components comply with the acceptance standards specified in the code.

4. Personnel who perform nondestructive examinations of welds shall be qualified and certified for each examination method in accordance with a program established by the employer of the personnel being certified based on the code requirements.

D. Inspections:

1. Inspections are the responsibility of the Owner and may be performed by employees of the Owner or party authorized by the Owner.

2. Prior to initial operation, the "Non-Boiler External Piping" installation shall be inspected to ensure compliance with the engineering design and with the material, fabrication, assembly, examination and test requirements of the code.

E. Field Testing: Provide testing of each section of piping in accordance with Part 3 of this Specification.

PART 2 - PRODUCTS

2.1 STEAM PIPING

A. Steam piping 4 inches to 24 inches shall be ASTM A53 or A106, seamless, Grade B, Standard Weight with the following schedule/wall thickness:

1. 10 inches and under - Schedule 40.
2. 12 inches and over - 0.375-inch.

2.2 STEAM CONDENSATE PIPING

A. Condensate piping 2 inches to 18 inches shall be ASTM A53 or A106, seamless, Grade B, Extra Strong Weight with the following schedule/wall thickness:

1. 8 inches and under - Schedule 80.
2. 10 inches and above - 0.500-inch.

2.3 ACCESSORY PIPING

A. Accessory piping shall be extra heavy (Schedule 80) ASTM A53, Grade B, seamless, all welded construction except as otherwise specified.

2.4 PIPE FITTINGS

A. Weld fittings shall comply with ANSI for steel butt-welding fittings (B16.11) where applicable, and material shall conform to Division 33 Section "Piping for Utility Distribution." Each fitting shall have manufacturer’s name or symbol, marked on fitting. Pipe fittings shall have same wall thickness as adjoining pipe.

B. Threaded fittings shall be Class 300 malleable (ductile) iron and conform to Division 33 Section "Piping for Utility Distribution."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piping:

1. Piping shall be installed in such a way that it will be free to expand and contract, without noise or damage to itself or to other structures.

2. Piping shall be installed in such a manner that it will NOT interfere with the necessary passage, head room or opening.

3. Risers and vertical pipe shall be plumb, straight and have no unnecessary fittings or offsets.

4. Filings, dust, and dirt shall be wiped from interior of the pipe or tubing before connections are made.

5. Changes in direction of piping shall be made using the appropriate fittings.

6. Pitch: Horizontal supply mains shall pitch up or down in the direction of flow as indicated.

7. Reducing fittings shall be used for changes in pipe sizes.

8. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the systems.

3.2 TESTING

A. Accessible Steam and Condensate Piping in Tunnels:

1. Leak Tests for Steam and Steam Condensate Piping:

a. Provide complete pneumatic testing for leaks of all piping systems in accordance with ASME B31.1 "Code for Pressure Piping," latest revision.

b. Apply not more than 25 psig for at least 10 minutes to identify major leaks.

c. Final test pressure shall be at least 1.5 the design pressure, but in no cases less than 150 psig.

d. Hold at full test pressure for a minimum of 10 minutes and gradually reduce to design pressure.

e. Following the application of pneumatic test pressure for at least 4 hours, examination shall be made for leakage of the piping and at all joints and connections using soap bubbles or other acceptable method to visually identify leaks.

f. If leaks are found, they shall be eliminated as appropriate, and the test repeated until no leakage is found.

2. In-Service Leak Test for Steam and Condensate:

a. An in-service test and examination using system steam is acceptable when other types of tests are not practical or when leak tightness is demonstrable due to the nature of the service; i.e., where shut-off valves are not available for isolating a line or where temporary closures are impractical.

b. The in-service test shall be conducted only after receiving written authorization from the Engineer.

c. This method shall also be used subsequent to pneumatic testing when used in lieu of hydrostatic testing.

d. When performing an initial service test, the piping system shall be gradually brought up to normal operating pressure and temperature and continuously held for a minimum time of 10 minutes.

e. Examination of leakage shall be made of joints and connections at that time.

B. Test Procedures:

1. Blank off or replace with spool pieces items of devices and equipment such as vessels, valves, instruments, etc. rated for pressure less than the test pressure. Reconnect equipment after testing.

2. Perform tests before piping is covered or concealed.

3. A pressure recorder shall monitor the testing of piping systems to verify test results.

C. Cycle Testing:

1. Following the completion of the leak testing procedures, the Contractor shall schedule with the Project Representative to have MSU staff conduct a cycle test on both the steam and condensate piping installed under this Contract.

a. All testing shall be scheduled through the Project Representative with a minimum of 72 hours' notice.

b. The cycle test may also be performed in conjunction with the in service test as authorized by the Owner.

c. The Contractor shall be present while the cycle test is being conducted.

2. The cycle test shall consist of a single warm-up cycle and cool-down cycle where the systems are gradually brought up to normal operating pressure and temperature for a period of 8 hours.

3. Prior to beginning the test, the Contractor shall mark the position of the steam and condensate expansion joints and guides at ambient conditions.

4. The position of the expansion joints and guides shall also be marked after the system has been brought up to operating temperature and pressures.

5. Following the cool down period, and when the system has been cooled to ambient conditions, the Contractor shall visually inspect these components including pipe slide supports to ensure their return to the initially marked position. The Contractor shall note misalignment and failure of the system to return to the original position.

3.3 CLEANING AND FLUSHING

A. Piping shall be cleaned before the installation, and flushed after the installation and before system start-up.

B. Equipment, detergents, solvents and other cleaning agents shall be furnished by a qualified water treatment service.

C. Disconnect piping to be flushed. Remove instruments which may be damaged by the cleaning procedures. Such items shall be replaced with spool pieces, plugs, or blind flanges.

D. Before the piping is put in service, clean it using a pressure tank with a hose equipped with a nozzle to direct a high velocity stream of water against the inside wall of the pipe. Make a minimum of 2 passes through the pipe with the hose. A minimum pressure of 250 psi shall be developed at the nozzle.

END OF SECTION 336320