

NEWCOMER ASSOCIATES

architecture + engineering



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PROJECT: Martin's Famous Pastry Shoppe
Transportation Cafe (Job #1730)
Chambersburg, PA

DATE: February 20, 2019

ADDENDUM #2

SPECIFICATIONS:

- 2.01 Section 22 05 29 Hangers & Supports for Plumbing & Equipment (revised specification attached dated 1/15/19)**
 - A. REVISE Materials to be stainless steel
- 2.02 Section 22 07 00 Plumbing Insulation (revised specification attached dated 1/15/19)**
 - A. ADDED Insulation jacket
- 2.03 Section 22 11 00 Facility Water Distribution (revised specification attached dated 1/15/19)**
 - A. ADDED Piping to be stainless steel
- 2.04 Section 23 05 29 Hangers & Supports for HVAC Piping & Equipment (revised specification attached 1/15/19)**
 - A. ADDED Materials to be stainless steel
- 2.05 Section 23 05 93 Testing, Adjusting and Balancing for HVAC (revised specification attached dated 1/15/19)**
 - A. ADDED T&B of existing systems

- 2.06 Section 23 09 23 Direct Digital Control System for HVAC (revised specification attached dated 1/15/19)**
 - A. REVISE Listed manufacturers

- 2.07 Section 23 09 93 Sequence of Operations for HVAC (revised specification attached dated 1/15/19)**
 - A. ADDED Exhaust fan on AHU

- 2.08 Section 23 74 13 Packaged, Outdoor, Central-Station Air-Handling Units (revised specification attached dated 1/15/19)**
 - A. ADDED Heresite coil coating
 - B. ADDED Stainless steel dampers

- 2.09 Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables**
 - A. ADDED limited mc cable & aluminum conduit

- 2.10 Section 26 05 29 Hangers and Supports for Electrical Systems (revised specification attached dated 1/15/9)**
 - A. ADDED Material to be stainless steel

- 2.11 Section 26 05 33 Raceway and Boxes for Electrical Systems (revised specification attached dated 1/15/19)**
 - A. ADDED Aluminum conduit

- 2.12 Section 27 05 33 Conduit and Boxes for Communications Systems (revised specification attached dated 1/15/19)**
 - A. ADDED Aluminum conduit

- 2.13 Section 28 31 00 Fire Detection and Alarm (revised specification attached 1/15/19)**
 - A. REVISE Section 1.6
 - B. REVISE Section 2.1
 - C. REVISE Section 1.9

DRAWINGS:

- 2.14 Sheet M101 Mechanical Renovation Plan (revision #1 dated 2/20/19)**
A. DELETE Keyed note #4
B. REVISE Duct lengths
- 2.15 Sheet M102 Roof Mechanical Plan (revision #1 dated 2/20/19)**
A. REVISE Size of AHU 101
- 2.16 Sheet M201 Mechanical Details and Schedules (revision #1 dated 2/20/19)**
A. REVISE Control schematic
B. REVISE Rooftop air handling unit schedule
C. REVISE AHU-101 detail
- 2.17 Sheet E101 Electrical Renovation Plans (revision #2 dated 2/20/19)**
A. ADDED keyed note #3
B. ADDED Elevations for tv outlets
- 2.18 Sheet E102 Enlarged Mezzanine Power Plan Revision #1 dated 2/20/19)**
A. REVISE Keyed note #3
- 2.19 Sheet E103 Roof Power Plan (revision #1 dated 2/20/19)**
A. ADDED Keyed note #3 & 4
B. ADDED Circuits at AHU
- 2.20 Sheet E501 Luminaire Schedule and Details (revision #1 dated 2/20/19)**
A. REVISE Panel schedule

END OF ADDENDUM #2

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Piping curbs
 - 6. Sleeves.
 - 7. Mechanical sleeve seals.
 - 8. Formed steel channel.
 - 9. Firestopping
 - 10. Equipment bases and supports.
 - 11. Flashing

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 07 90 00 - Joint Protection: Product requirements for sealant materials for placement by this section.
 - 3. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.9 - Building Services Piping.

- B. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

- E. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

- F. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: Conform to UL to achieve fire ratings as noted on Drawings for adjacent construction.
- B. Firestop interruptions to fire rated assemblies, materials, and components. Reference Division 07 84 00 for details.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide written authorization from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required UL listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.
- B. Perform Work in accordance with local standards.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Carpenter & Paterson Inc.
 - 2. Creative Systems Inc.
 - 3. Flex-Weld, Inc.
 - 4. Glope Pipe Hanger Products Inc.
 - 5. Michigan Hanger Co.
 - 6. Superior Valve Co.
 - 7. Substitutions: Section 01600 - Product Requirements.
- B. Plumbing Piping - DWV - Sanitary and Storm:
 - 1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes ½ to 1-1/2 inch: Stainless steel, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 inches and Larger: Stainless steel, adjustable, clevis.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

4. Multiple or Trapeze Hangers: Stainless Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Stainless steel hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded stainless steel bracket and stainless steel clamp.
7. Vertical Support: Stainless steel riser clamp.
8. Floor Support: Stainless steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Theaded rod: Stainless steel threaded rod with white PVC thread covers. PVC thread covers shall cover all threads not engaged. Threaded rod shall be on an internal diameter such that threads are tight to inside of the cover such that covers are not loose.
10. Bolts/Nuts Hanger Clamps and Securing Hardware: Stainless steel.

C. Plumbing Piping - Water:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Stainless steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Stainless steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Stainless steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Stainless steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes 3 inches and Smaller: Stainless steel hook.
7. Wall Support for Pipe Sizes 4 inches and Larger: Welded stainless steel bracket and stainless steel clamp.
8. Vertical Support: Stainless steel riser clamp.
9. Floor Support for Cold Pipe: Stainless steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.
10. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Stainless steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.
11. Theaded rod: Stainless steel threaded rod with white PVC thread covers. PVC thread covers shall cover all threads not engaged. Threaded rod shall be on an internal diameter such that threads are tight to inside of the cover such that covers are not loose.
12. Bolts/Nuts Hanger Clamps and Securing Hardware: Stainless steel.

2.2 INSERTS

A. Manufacturers:

1. Grinnel.
2. Tolco.
3. Substitutions: Section 01 60 00 - Product Requirements.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Inserts: Stainless steel case of stainless steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 FLASHING

- A. Metal Flashing: 26 gage thick stainless steel.
- B. Metal Counterflashing: 22 gage thick stainless steel.
- C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gage stainless steel minimum; 16 gage stainless steel at fire resistant elements.

2.4 PIPING CURBS

- A. Manufacturers:
 - 1. Thycurb
 - 2. Curbs Plus
 - 3. Substitutions: Section 01600 - Product Requirements
- B. Fabrication: Welded 18 gage stainless steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. ABS thermoplastic korad acrylic or stainless steel cover. Provide graduated boots for top entrance and 2x8 wood nailer for side entrance. Coordinate with roofing contractor to install curb and roof cricket.
- C. Provide curbs for piping penetrations of roofing where the roof has a slope of 1" in 12" or less. Provide boots for piping penetrations where slope is greater than 1" in 12"

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick stainless steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick stainless steel.
- C. Sealant: Acrylic (where not through rated entity); refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Ferrous elements shall be stainless steel.

2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: 12 gage thick stainless steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

- A. Manufacturers:
 - 1. 3M Fire Protection Products.
 - 2. Nelson Firestop Products.
 - 3. Johns Manville
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Materials:
 - 1. Caulk: CP25 (must be brick red)
 - 2. Wrap/Strip: FS-195
 - 3. Collar: RC-1
 - 4. Composite Sheet: CS-195
 - 5. Fire Barrier Moldable putty
 - 6. Fire Dam Spray

2.9 FIRESAFING

- A. Manufacturer
 - 1. USG Acoustical Products
- B. Materials
 - 1. 4 inch mineral fiber stuffing insulation
 - 2. Density: 4 lb/cu ft.

2.10 ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- C. Labels: Red permanent marking "Fire Rated Assembly-Do not Disturb-See maintenance Instructions", include testing agency designation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install non-combustible backing damming materials to arrest liquid material leakage.
- D. Remove backing damming materials after firestopping material has solidified in exposed areas.
- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Where inserts are omitted, drill through concrete slab/plank from below and provide through-bolt with recessed square steel plate and nut above flush with top of, recessed into and grouted flush with slab/plank as indicated on plans or directed by plank manufacturer. Where slab is utilized and direction is not given on plans then confirm with architect for method of attachment.

3.4 FIRESTOPPING/FIRESAFING

- A. Install as indicated by UL to maintain rating indicated by architectural plans.

3.5 INSTALLATION – DUST MITIGATION

- A. Seal pipes at any wall airtight. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe and between sleeve and wall.

3.6 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with manufacturer's recommendation and this specification.
- B. Support horizontal piping as scheduled.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support vertical piping at every floor.
- F. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- G. Support riser piping independently of connected horizontal piping.
- H. Design hangers for pipe movement without disengagement of supported pipe.
- I. Piping shall be attached such that there is a 3" air space between any pipe and wall, ceiling or structural member such that cleaning pipe may be facilitated. Insulated pipe shall maintain a 3" air space between the insulation and any wall, ceiling or structural member. Refer to Section 22 07 00.

3.7 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 4 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.8 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- C. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- D. Flash and counter-flash roof curbs with sheet metal; seal watertight. Attach counterflashing and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars and pipe boots tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.9 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves two pipe sizes larger than penetrating pipe to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates a fire rated or smoke rated floor, ceiling, or wall, close off space between pipe or duct and adjacent work with approved firestopping system. Provide close fitting metal collar or escutcheon covers at both sides of penetration where penetration is exposed.
- F. Install stainless steel escutcheons at finished surfaces.

3.10 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.11 CLEANING

- A. Section 01 70 00 - Execution Requirements: Requirements for cleaning.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

B. Clean adjacent surfaces of firestopping materials.

3.12 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plumbing piping insulation, jackets and accessories.
 - 2. Plumbing equipment insulation, jackets and accessories.

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
 - 3. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment: Execution requirements for sleeves and protective measures to be taken for the installation of insulation.
 - 4. Section 22 11 00 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
 - 5. Section 22 13 00 - Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - 5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - 6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
 - 7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 - 9. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

10. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
14. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
15. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
16. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
17. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Samples: Submit two samples (1' long) of 1" closed cell foam insulation when closed cell foam insulation is to be used anywhere on project.
- D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Pipe insulation shall have a maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Perform Work in accordance with local standards.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.
- D. Fibrous insulation such as fiberglass insulation found by architect's construction administrator to be moist or to have been exposed to wet conditions shall be removed from job site and disposed of regardless of whether insulation has been installed

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber Insulation Products:
 - 1. Knauf.
 - 2. Johns Manville.
 - 3. Owens-Corning.
 - 4. CertainTeed.
 - 5. Substitutions: Section 01 60 00 - Product Requirements

- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
 - 1. Armacell, LLC. Armaflex.
 - 2. Aeroflex. Aerocell.
 - 3. Nomaco. K-flex.
 - 4. Substitutions: Section 01 60 00 - Product Requirements

- C. Manufacturers for Plenum Fire Wrap
 - 1. 3M Model "5A".
 - 2. Thermal Ceramics
 - 3. Substitutions: Section 01 60 00 - Product Requirements

2.2 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form
 - 1. Minimum Service Temperature: -40 deg. F
 - 2. Maximum Service Temperature: 220 deg F.
 - 3. Connection: Waterproof vapor barrier adhesive or hot melt fuse seal joint method used with Polyolefin insulation. Compatible with insulation and as recommended by the insulation manufacturer

- B. Elastomeric Foam Adhesive:
 - 1. Air dried, contact adhesive, compatible with insulation.

- C. Flexible elastomeric cellular insulation shall have a flame spread index of 25 or less and a developed smoke index of 50 or less when tested in accordance with ASTM E 84.

- D. Cell Structure shall be closed type.

- E. Color to be white.

- F. Alternative Material: As an alternative to flexible elastomeric foam insulation Polyisocyanurate insulation by Dyplast may be used. Polyisocyanurate type insulation shall be ISO-C1 2.0 type and shall be of thicknesses equal to that as specified for cellular elastomeric foam. Heat shrunk and welded PVC covers shall be provided as for elastomeric foam and installation shall be otherwise be as specified for cellular foam.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.3 PLENUM FIRE WRAP

- A. Plenum Fire wrap: ASTM C411, C518, E84, E136, and UL 910. 1/2" inorganic blanket encapsulated with scrim-reinforced foil. Installation of plenum fire wrap shall allow 1" diameter and larger piping constructed of PVC, CPVC, PB, PE, PP, PVDF or ABS plastics to be installed within a return, supply, exhaust or transfer air plenum when installed as directed by manufacturer.

2.4 PIPE AND EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Jacket:
 - 1. Manufacturers:
 - a. Knauf: model Proto
 - b. Johns Manville International
 - c. Ceelco
 - d. Substitutions: Section 01600 - Product Requirements.
 - 2. Product Description: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color
 - 3. Minimum Service Temperature: -40 degrees F.
 - 4. Maximum Service Temperature: 150 degrees F.
 - 5. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
 - 6. Thickness: 10 mil.
 - 7. Connections: Brush on welding adhesive.
 - 8. PVC jacketing shall have a flame spread index of 25 or less and a developed smoke index of 50 or less when tested in accordance with ASTM E 84.
- B. Aluminum Pipe Jacket: ASTM B209 formed aluminum sheet.
 - 1. Thickness: 0.016 inch thick sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.5 PIPE AND EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self adhesive closure. Thickness to match pipe insulation.
- F. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of fire resistance rated assemblies.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies (not including booster pumps), and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Hot Piping Systems less than 140 degrees F:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 - 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Hot Piping Systems greater than 140 degrees F:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
 - 3. Insulate flanges and unions at equipment.

- F. Inserts and Shields:
 - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

- G. Insulation Terminating Points:
 - 1. Coil Branch Piping: water piping and associated components up to coil connection.
 - 2. Condensate Piping: Insulate entire piping system and components to prevent condensation.

- H. Closed Cell Elastomeric Insulation:
 - 1. Push insulation on to piping.
 - 2. Miter joints at elbows.
 - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 4. When application requires multiple layers, apply with joints staggered.
 - 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
 - 6. Provide heat shrunk and welded PVC jacketing at all locations except where provided with aluminum jacketing.

- I. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

- J. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- K. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.
- L. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.
- M. Prepare exposed pipe insulation for finish painting. Refer to Section 09 90 00.
- N. Apply Plenum Fire Wrap to plastic piping located in supply, return, transfer or exhaust plenum.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F Or Less:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment Containing Fluids Over 140 degrees F:
 - 1. Insulate flanges and unions with removable sections and jackets.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.
- I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- J. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- K. Prepare exposed equipment insulation for finish painting. Refer to Section 09 90 00.

3.4 SCHEDULES

- A. Domestic Hot Water Supply:
 - 1. Cellular Elastomeric Foam Insulation:
 - a) Pipe Size Range: 1/2- 6 inch
 - b) Thickness: 1-1/2 inch
 - c) Include PVC jacket color coded
- B. Domestic Hot Water Re-circulation:
 - 1. Cellular Elastomeric Foam Insulation:
 - a) Pipe Size Range: 1/2 - 6 inch
 - b) Thickness: 1-1/2 inch
 - c) Include PVC jacket color coded
- C. Tempered Domestic Water Supply:
 - 1. Cellular Elastomeric Foam Insulation:
 - a) Pipe Size Range: 1/2 - 6 inch
 - b) Thickness: 1-1/2 inch
 - c) Include PVC jacket color coded
- D. Domestic Cold Water:
 - 1. Cellular Elastomeric Foam Insulation:
 - a) Pipe Size Range: 1/2 to 2 inch
 - (1) Thickness: 1/2 inch
 - (2) Include PVC jacket color coded
 - b) Pipe Size Range: 2-1/2 – 10 inch
 - (1) Thickness: 1 inch
 - (2) Include PVC jacket color coded
- E. PVC Piping in return, supply, exhaust or transfer air plenums.
 - 1. Plenum Fire Wrap
 - a) Pipe Size Range: 1 inch and smaller

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- (1) Piping is not allowed in chase.
 - b) Pipe Size Range: 1 inch and larger
 - (1) Thickness: 1/2 inch
- F. CPVC Piping in return, supply, exhaust or transfer air plenums.
 - 1. Plenum Fire Wrap
 - a) Pipe Size Range: 1 inch and smaller
 - (1) Piping is not allowed in chase.
 - b) Pipe Size Range: 1 inch and larger
 - (1) Thickness: 1/2 inch
 - 2. Blazemaster fire sprinkler piping by Noveon does not require insulation in return air plenums unless otherwise required. Chemdrain chemical waste piping by Charlotte Pipe and Foundry does not require insulation in return air plenums unless otherwise required.
- G. Plumbing Vents Within 10 feet of Exterior:
 - 1. Elastomeric Foam Insulation:
 - a) Thickness: 1 inch
- H. Other Systems
 - 1. Cellular Elastomeric Foam Insulation:
 - a) Pipe Size Range: 1/2 to 2 inch
 - (1) Thickness: 1/2 inch
 - (2) Include PVC jacket color coded
 - b) Pipe Size Range: 2-1/2 – 10 inch
 - (1) Thickness: 1 inch
 - (2) Include PVC jacket color coded
- I. Domestic Hot Water Storage Tanks:
 - 1. Elastomeric Foam Insulation: 1 inch thick.
- J. Domestic Cold Water Storage Tanks:
 - 1. Elastomeric Foam Insulation: 1 inch thick.

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Buried domestic water piping.
 2. Domestic water piping, above grade.
 3. Unions and flanges.
 4. Valves.
 5. Flow control valves.
 6. Water pressure reducing valves.
 7. Relief valves.
 8. Recessed valve box.
 9. Hose bibs.
 10. Hydrants.
 11. Backflow preventers.
 12. Trap Primers.
 13. Water hammer arresters.
 14. Thermostatic mixing valves.
 15. Pressure balanced mixing valves.
 16. Diaphragm-type compression tanks.
 17. Pressure gages.
 18. Pressure gage taps.
 19. Thermostats.
 20. Piping Expansion
- B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 2. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
 3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
 4. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
 5. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
 6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

- B. American Society of Mechanical Engineers:
 - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 4. ASME B31.9 - Building Services Piping.
 - 5. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
 - 6. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
 - 7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

- C. American Society of Sanitary Engineering:
 - 1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
 - 2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
 - 3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
 - 4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
 - 5. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.
 - 6. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).
 - 7. ASSE 5015 - Performance Requirements for Testing Double Check Backflow Prevention Assemblies (DC) and Double Check Fire Protection Backflow Prevention Assemblies (RPDF).

- D. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - 4. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 5. ASTM B32 - Standard Specification for Solder Metal.
 - 6. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
 - 7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 8. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 9. ASTM E1 - Standard Specification for ASTM Thermometers.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

10. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
 11. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 6. AWWA C651 - Disinfecting Water Mains.
- G. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 67 - Butterfly Valves.
 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 6. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 7. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 8. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
 9. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 10. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- H. Plumbing and Drainage Institute:
1. PDI WH201 - Water Hammer Arrester Standard.
- I. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
 2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.
- J. NSF International
1. Standard 14 – Plastic Piping System Components and Related Materials.
 2. Standard 61 – Drinking Water System Components – Health Effects.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.3 SUBMITTALS

- A. Section 01 33 00 Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves and equipment.
- C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with latest International Plumbing Code and local municipality requirements, whichever is more stringent.
- B. Maintain one copy of each document on site.
- C. ProPress fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 50 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish four loose keys for outside hose bibs and a spare cartridge for each size of thermostatic mixing valve.

PART 2 PRODUCTS

2.1 BURIED DOMESTIC WATER PIPING

- A. This section shall apply to all buried domestic water piping installed in any of the following locations.
 1. Below the building envelope and up to five feet away from the exterior of the building envelope.
 2. Where specifically called out on plans as part of this division=s work.
 3. The connecting piping to an item specifically called out on plans as part of this division=s work.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

4. Below the overhang of any building element.

B. Ductile Iron Pipe: AWWA C151

1. Fittings: AWWA C110, ductile or gray iron, standard thickness.
2. Joints: AWWA C111, rubber gasket with rods.
3. Jackets: AWWA C105 polyethylene jacket.

C. Copper Tubing: ASTM B88, Type K, annealed.

1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 WATER PIPING, ABOVE GRADE

A. Stainless Steel Pipe: ASTM A 312/A 312 M Schedule 5S (Viega)

1. Fittings: ASTM A 815/A 815M, Stainless Steel press fittings as manufactured by Viega.

2.3 FLANGES, UNIONS, AND COUPLINGS

A. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide and install per Section 220529 of this specification.

2.5 VALVES

A. Globe Valves:

1. Manufacturers:
 - a. Watts
 - b. Appollo.
 - c. Nibco.
 - d. Wilkens.
 - e. Substitutions: Section 016000 - Product Requirements.
2. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, hand wheel, Teflon disc, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 85, Class 125, iron body, bronze trim, hand wheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

4. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.
- B. Bronze Ball Valves:
1. Manufacturers:
 - a. Watts.
 - b. Appollo.
 - c. Nibco.
 - d. Wilkens.
 - e. Viega.
 - f. Substitutions: Section 016000 - Product Requirements.
 2. 4 inches and Smaller: MSS SP 110, Class 150, 400 psi CWP, bronze, two piece body, stainless steel ball, full port, teflon seats and stuffing box ring, blow-out proof stem, solder or threaded ends with union.
- C. Butterfly Valves:
1. Manufacturers:
 - a. Watts
 - b. Nibco.
 - c. Wilkens.
 - d. Stockham.
 - e. Substitutions: Section 016000 - Product Requirements.
 2. 1-1/2 inches and Larger: MSS SP 67, cast or ductile iron body, stainless steel disc, resilient replaceable EPDM seat, grooved ends, extended neck, infinite position lever handle with memory stop
- D. Flow Controls: Balancing Valves
1. Manufacturers:
 - a. Taco Model CS series - circuit setter.
 - b. Watts
 - c. Bell and Gosset
 - d. Armstrong
 - e. Substitutions: Section 016000 - Product Requirements.
 2. Up to and including 3/4" bronze body with soldered connections, threaded series (T) for larger sizes in same construction.
 3. 100% positive, lead proof shut-off, 2 gpm at minimum 225 psi and 300 degree F with hidden memory stop and anti-tamper lock feature.
 4. Balance to minimum at each valve per plans using Taco Model 789 readout meter.
- E. Horizontal Swing Check Valves:
1. Manufacturers:
 - a. Watts
 - b. Crane Valve, North America
 - c. Hammond Valve
 - d. Milwaukee Valve Company
 - e. NIBCO, Inc.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- f. Stockham Valves & Fittings
 - g. Substitutions: Section 016000 - Product Requirements.
 - 2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
 - 3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
 - F. Spring Loaded Check Valves:
 - 1. Manufacturers:
 - a. Watts
 - b. Crane Valve, North America
 - c. Hammond Valve
 - d. Milwaukee Valve Company
 - e. NIBCO, Inc.
 - f. Stockham Valves & Fittings
 - g. Substitutions: Section 016000 - Product Requirements
 - 2. 2 inches and Smaller: MSS SP 80, class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
 - 3. 2-1/2 inches and Larger: MSS SP 71, Class 125, globe style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends

2.6 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Watts
 - 2. Wilkens
 - 3. Substitutions: Not allowed
- B. 1-1/2" inches and Smaller: MSS SP 80, direct acting, bronze body, stainless steel and-thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded, single union, or double union ends. Watts series 223 or equal.
- C. 2 inches and Larger: MSS SP 85, flow control type, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged. Watts series ACV 115-7 or equal.

2.7 RELIEF VALVES

- A. Manufacturers:
 - 1. Wilkins
 - 2. Watts
 - 3. Substitutions: Section 016000 - Product Requirements.
- B. Pressure Relief:
 - 1. ANSI Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuate. Pressure relief valves shall be set at 125 psig.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Temperature and Pressure Relief:
 - 1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, pressure relief shall be set at not more than 125 psig capacity ASME Section IV certified and labeled.
- D. Vacuum Relief:
 - 1. ANSI Z21.22 certified. The vacuum relief valve shall have all brass body and protective cap.

2.8 STRAINERS

- A. Manufacturers:
 - 1. Watts.
 - 2. Appollo.
 - 3. Nibco.
 - 4. Wilkens.
 - 5. Substitutions: Section 016000 - Product Requirements
- B. 2 inch and Smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
- C. 1-1/2 inch to 4 inch: Class 125, flanged iron body, Y pattern with 1/16-inch stainless steel perforated screen.
- D. 5 inch and Larger: Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

2.9 HOSE BIBS (HB-1)

- A. Manufacturers:
 - 1. Zurn
 - 2. Myfab
 - 3. Watts
 - 4. Substitutions: Section 016000 - Product Requirements
- B. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with hand wheel, vacuum breaker in conformance with ASSE 1011.

2.10 HOSE BIBS (HB-2)

- A. Manufacturers:
 - 1. Zurn
 - 2. Myfab
 - 3. Watts
 - 4. Substitutions: Section 016000 - Product Requirements

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with removable key handle, vacuum breaker in conformance with ASSE 1011.

2.11 WALL HYDRANT (DWH-1)

- A. Manufacturers:
 - 1. Woodford Model: RB-65
 - 2. Substitutions: Section 016000 - Product Requirements.
- B. Body: Anti-siphon, automatic draining, non-freeze type integral backflow preventer, bronze casing and interior parts, nickel bronze box, and hinged cover with operating key and AWATER@ cast on cover. Body shall be round and designed specifically for installation in tilt-up wall construction. Cover shall be chrome plated brass.

2.12 ROOF HYDRANT (RH-1)

- A. Manufacturers:
 - 1. Woodford Model: RHY2
 - 2. Substitutions: Section 016000 - Product Requirements.
- B. Body: Exposed, non-freezing yard hydrant, with Dura-Coated cast iron head and lift handle with lock option. Bronze interior parts and galvanized steel casing with bronze valve housing and 1/8" IP drain port in housing. Provide 1-1/4" galvanized steel shaft and 1" supply. Unit shall be supply with a well and boot for flashing. Unit shall be provided with underdeck clamp and mounting bolts. Include check valve in take-off piping.
- C. Unit shall drain while connected to 50' of hose.
- D. Route waste as condensate to place of disposal.

2.13 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Watts.
 - 2. Wilkens
 - 3. Ames
 - 4. Substitutions: Not allowed.
- B. Reduced Pressure Backflow Preventers:
 - 1. Comply with ASSE 1013.
 - 2. Bronze body, with bronze or stainless steel internal parts and stainless steel springs for sizes 1/4" through 2". Cast iron body with FDA approved epoxy coating, with stainless steel internal parts and stainless steel springs for sizes 2-1/2" through 10".
 - 3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with four test cocks.
 4. Assembly shall include two quarter turn brass/bronze ball valves and bronze strainer for sizes 1/4" through 2". Assembly shall include FDA approved epoxy coated cast iron quarter turn ball valves and FDA approved epoxy coated cast iron strainer for sizes 2-1/2" through 10".
 5. Provide indirect waste connection to floor drain per manufacturer with Model AG air gap fitting.
- C. Double Check Backflow Preventers:
1. Comply with ASSE 1015.
 2. Bronze body, with bronze or stainless steel internal parts and stainless steel springs for sizes 1/4" through 2". Cast iron body with FDA approved epoxy coating, with stainless steel internal parts and stainless steel springs for sizes 2-1/2" through 10".
 3. Two independently operating, spring loaded check valves; assembled with four test cocks.
 4. Assembly shall include two quarter turn brass/bronze ball valves and bronze strainer for sizes 1/4" through 2". Assembly shall include FDA approved epoxy coated cast iron quarter turn ball valves and FDA approved epoxy coated cast iron strainer for sizes 2-1/2" through 10".
- D. Dual Check Backflow Preventers:
1. Comply with ASSE 1024.
 2. Bronze body, with plastic check valves, silicone disks and stainless steel springs; assembled with three plugged test ports.
 3. Two independently operating, spring loaded check valves.
- E. Coffee Makers, Carbonated Beverage Dispensers, Tea Makers or Other Beverage Dispensers:
1. Provide NSF approved dual check valve meeting ASSE 1022 and 1032, Watts SD-3 or equal.

2.14 WATER HAMMER ARRESTORS

- A. Manufacturers:
1. Zurn Model Z-1700.
 2. Sioux Chief
 3. Watts
 4. Wilkens
 5. Substitutions: Section 016000 - Product Requirements.
- B. ANSI 1010; copper construction, piston type sized in accordance with PDI WH-201.
- C. Pre-charged suitable for operation in temperature range -100 to 300 degrees F and maximum 350 psi working pressure.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- D. Provide on all quick-close fixture connections based on schedule and symbols provided.

2.15 LAVATORY SUPPLY TRAP PRIMERS (TP-1)

- A. Manufacturers:
 - 1. Precision Plumbing Products: PR01-500ULP
 - 2. Zurn
 - 3. Sioux Chief
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. ASSE 1018 or ASSE 1044 listed; chrome plated brass primer containing no springs or diaphragms. Primer shall include check valve seals and vacuum breaker and 5/8" compression fitting.
- C. Operating pressure 35 to 75 psig. AO@ ring seals tested for reliability at a temperature range from -40 to 450 degrees F.
- D. Primer valve shall be automatically activated when it senses water flow.
- E. Trap primer shall be designed for connection to cold water supplies below lavatory a minimum 12" above floor.
- F. Include angle stop with 5/8" compression fitting and 2" copper tubing. Angle installed with trap primer shall replace standard angle stop supplied with lavatory fixture.

2.16 SINGLE TRAP PRIMERS (TP-2)

- A. Manufacturers:
 - 1. Precision Plumbing Products PR-500
 - 2. Zurn
 - 3. Sioux Chief
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. ASSE 1018 or ASSE 1044 listed; chrome plated brass primer containing no springs or diaphragms. Primer shall include check valve seals and vacuum breaker 2" inlet and outlet.
- C. Operating pressure 35 to 75 psig. AO@ ring seals tested for reliability at a temperature range from -40 to 450 degrees F.
- D. Primer valve shall be automatically activated when it senses a pressure drop between 5 and 10 psi.
- E. Trap primer shall be designed for connection to cold water supplies 1-1/2" to 2" in size and installed a minimum 12" above floor.
- F. Include 2" copper tubing.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.17 MULTIPLE TRAP PRIMERS (TP-3)

- A. Manufacturers:
 - 1. Precision Plumbing Products PR-500/DU-X
 - 2. Zurn
 - 3. Sioux Chief
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. ASSE 1018 or ASSE 1044 listed; chrome plated brass primer containing no springs or diaphragms. Primer shall include check valve seals and vacuum breaker 2" inlet and outlet.
- C. Operating pressure 35 to 75 psig. AO@ ring seals tested for reliability at a temperature range from -40 to 450 degrees F.
- D. Primer valve shall be automatically activated when it senses a pressure drop between 5 and 10 psi.
- E. Trap primer shall be designed for connection to cold water supplies 1-1/2" to 2" in size and installed a minimum 12" above floor.
- F. Include 2" copper tubing and distribution unit designed for the number of traps served.

2.18 DIGITAL THERMOSTATIC MIXING VALVES CENTER

- A. Manufacturers:
 - 1. Armstrong – The Brain
 - 2. Powers - Intellistation
 - 3. Substitutions: No substitutions allowed.
- B. System:
 - 1. Digital Recirculating Valve shall be supplied with lead free sub-assemblies that are pressure tested by the factory. DMCBS Flex is assembled with the following water connections: hot water inlet, cold water inlet, mixed water outlet, recirculation return water inlet and return to heater outlet.
 - 2. System shall comprise of pre-assembled manifolds that include check valves, strainers, unions and ball valves on each of the inlet water connections. DRV with union connections, Sage control module and unistrut for wall mounting. Manifolds to be assembled on site and unistrut to be anchored to mounting surface. Sage module to be mounted and wired on site.
- C. Digital Recirculating Thermostatic Mixing Valve (DVR):
- D. Recirculating Valve shall be digital of lead free stainless steel/polymer construction.
- E. B. DRV shall have 3" inlet/outlet connections, deliver a mixed water flow of 165GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- F. DRV shall have all of the following operational capabilities:
- G. +/- 2F water temperature control
 - 1. 2F minimum inlet to outlet water temperature differential
 - 2. Automatic shutoff of hot water flow upon cold water inlet supply failure.
 - 3. Automatic shutoff of hot water flow in the event of a power failure
 - 4. Programmable set point range of 81-158°F (27-70°C)
 - 5. Programmable thermal disinfection mode
 - 6. Programmable 1st level hi/lo temp alarm display
 - 7. Programmable temperature error level for safety shutdown
- H. DRV shall have all of the following connectivity capabilities:
 - 1. SPCO relay outputs which are energized during operation.
 - 2. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
 - 3. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
 - 4. RS485 Serial Port for connection to a performance matched hot water monitoring system.
- I. DRV shall be UL listed, compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
- J. Building Automation interface: Interface module available with Building Automation System (BAS) specific ProtoCessor cards for system which operate on the Modbus, BACnet, or Lonworks protocols.
 - 1. System shall communicate the following inputs:
 - a. Set Point
 - b. Inlet/Outlet Temperature
 - 2. System shall communicate the following diagnostic error messages:
 - a. Over Temperature Alert
 - b. PCB error
 - c. Thermistor Error
 - d. Motor Error/Emergency Mode
 - e. Battery Error

2.19 DIAPHRAGM-TYPE COMPESSION TANKS

- A. Manufacturers:
 - 1. Amtrol
 - 2. Wessel
 - 3. Watts
 - 4. Armstrong
 - 5. Substitutions: Section 016000 - Product Requirements.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 55 psig.
- D. Size: Based on drawing details for domestic water.
- E. Accessories:
 - 1. Shut-off valve on all outlets and inlets.
 - 2. Integral thermometer on outlet.
 - 3. Integral check valves on all inlets.
 - 4. Wall brackets.
 - 5. Integral thermostatic return limiter
 - 6. Integral sight flow indicator
 - 7. Spare cartridge for each valve.
 - 8. Include locking manufacturer cabinet with hinged door.

2.20 PRESSURE GAGES

- A. Manufacturers:
 - 1. Miljoco.
 - 2. Watts.
 - 3. Wilkins.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Stainless steel.
 - 2. Bourdon Tube: Brass.
 - 3. Dial Size: 2-1/2 inch diameter.
 - 4. Mid-Scale Accuracy: Two percent.
 - 5. Scale: 0-100 Psi.
 - 6. Gage shall be UL 393 listed when used for water conveying lines.

2.21 PRESSURE GAGE TAPS

- A. Manufacturers:
 - 1. Miljoco.
 - 2. Watts.
 - 3. Wilkins.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Needle Valve: Brass, 1/4 inch NPT for maximum 3000 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections. Miljoco model 1200.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.22 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Miljoco.
 - 2. Substitutions: Section 01 60 00 - Product Requirements
- B. Thermometer: ASTM E1, green appearing mercury, lens front tube, cast aluminum case with enamel finish and brass swivel with 1-1/8" jam nut.
 - 1. Size: 7-inch scale.
 - 2. Window: Clear glass.
 - 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
 - 4. Accuracy: 1 percent.
 - 5. Calibration: Degrees F.

2.23 Steel or Copper Piping Expansion Compensation

- A. Manufacturers:
 - 1. Hyspan
 - 2. Substitutions: Section 01 60 00 - Product Requirements
- B. Construction: Expansion Joints
 - 1. Maximum Joint Travel length: 6".
 - 2. Maximum Axial Compression: 2".

2.24 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type as specified in Section 310513 and 310516.
- B. Cover: Fill Type as specified in Section 312323.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Inserts:
 - 1. See Section 22 05 29.
- B. Pipe Hangers and Supports:
 - 1. See Section 22 05 29.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 6 inches below local frost line.
- C. Establish minimum separation of 18 inches from other services or in accordance with local water authority requirements, whichever is greater.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Excavate pipe trench in accordance with Section 31 23 16 and 31 23 17.
- F. Install pipe to elevation as indicated on Drawings.
- G. Install pipe on prepared bedding.
- H. Route pipe in straight line.
- I. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- J. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section. Coordinate with division 08 31 13.
- K. Install plastic ribbon tape continuous over top of pipe. Coordinate with Section 220553.
- L. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 31 23 23.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 4 inches compacted layers to 12 inches minimum cover over top of jacket. Compact in accordance with Section 02320 or to local water authority standard, whichever is more stringent.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.
 - 6. Establish elevations of buried piping outside the building to obtain minimum depth of 6 inches below local frost line.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

7. Excavate and backfill in accordance with Section 312317.

3.5 INSTALLATION - ABOVE GROUND PIPING

- A. Install Work in accordance with International Plumbing Code or local plumbing authority standards, whichever is more stringent.
- B. Install non-conducting dielectric connections wherever jointing dissimilar metals. Provide and install plastic isolating grommets on all metal pipe that penetrates and routes through steel/metal framing.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- E. Group piping whenever practical at common elevations.
- F. Slope water piping minimum 0.25 percent and arrange to drain at low points.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 250529.
- I. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 083113.
- J. Establish elevations of buried piping outside the building to obtain minimum depth of 6 inches below local frost line.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- N. Install water piping in accordance with ASME B31.9.
- O. Sleeve pipes passing through partitions, walls and floors. Refer to Section 250529.
- P. Install unions downstream of valves and at equipment or apparatus connections.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- Q. Install valves with stems upright or horizontal, not inverted.
- R. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- S. Install globe or balancing valves for throttling, bypass, or manual flow control services.
- T. Provide ball or lug end butterfly valves adjacent to equipment when functioning to isolate equipment.
- U. Provide spring loaded check valves on discharge of water pumps.
- V. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- W. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.
- X. Install water hammer arresters complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets and other listed quick-closing fixtures.
- Y. Install lavatory trap primers in the same accessible cavity as lavatory shutoff. Where lavatory shutoff is exposed primer may be exposed. All non-chrome plated piping and parts downstream of shutoff shall be painted to match adjacent wall.
- Z. Install multiple trap primers a minimum of 12" above floor for every 20' of water line between trap primer and furthest floor drain. Install distribution unit level with clear plastic cover, in accessible location. Connection to water supply shall be from above such that dirt and debris in trap primer supply are minimized.
- AA. Contractor shall coordinate all core drilled, saw cut or otherwise created holes including but not limited to water risers and runouts with concrete reinforcement.

3.6 INSTALLATION – SERVICE CONNECTIONS

- A. Provide new water service complete with approved water meter. Provide backflow protection as required by Guilford Water.
- B. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 6 inches minimum below grade. Size for minimum of 2 inches of loose batt.

3.7 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Disinfecting of Domestic Water.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Prior to starting work, verify system is complete, flushed and clean.
- D. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- E. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
- F. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
- G. Maintain disinfectant in system for 24 hours.
- H. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
- I. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
- J. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing
- B. Test piping system in accordance with International Plumbing Code.

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Piping curbs
 - 6. Sleeves.
 - 7. Mechanical sleeve seals.
 - 8. Formed steel channel.
 - 9. Firestopping
 - 10. Equipment bases and supports.
 - 11. Flashing

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 07 90 00 - Joint Protection: Product requirements for sealant materials for placement by this section.
 - 3. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.9 - Building Services Piping.

- B. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

- E. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

- F. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: Conform to UL to achieve fire ratings as noted on Drawings for adjacent construction.
- B. Firestop interruptions to fire rated assemblies, materials, and components. Reference Division 07 84 00 for details.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide written authorization from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required UL listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.
- B. Perform Work in accordance with local standards.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Rocket Rack
 - 2. Substitutions: No substitutions.
- B. HVAC (Hydronic) piping:
 - 1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Stainless steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Stainless steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches: Stainless steel, adjustable, clevis.
 - 5. Multiple or Trapeze Hangers: Stainless steel channels with welded spacers and hanger rods.
 - 6. Wall Support for Pipe Sizes 3 inches and Smaller: Stainless steel hook.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

7. Wall Support for Pipe Sizes 4 inches and Larger: Welded stainless steel bracket and stainless steel clamp.
8. Vertical Support: Stainless steel riser clamp.
9. Floor Support for Cold Pipe: Stainless steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.
10. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Stainless steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.
11. Theaded rod: Stainless steel threaded rod with white PVC thread covers. PVC thread covers shall cover all threads not engaged. Threaded rod shall be on an internal diameter such that threads are tight to inside of the cover such that covers are not loose.
12. Bolts/Nuts Hanger Clamps and Securing Hardware: Stainless steel.

2.2 INSERTS

- A. Manufacturers:
 1. Grinnel.
 2. Tolco.
 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Inserts: Stainless steel case of stainless steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 FLASHING

- A. Metal Flashing: 26 gage thick stainless steel.
- B. Metal Counterflashing: 22 gage thick stainless steel.
- C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gage stainless steel minimum; 16 gage stainless steel at fire resistant elements.

2.4 PIPING CURBS

- A. Manufacturers:
 1. Thycurb
 2. Curbs Plus
 3. Substitutions: Section 01600 - Product Requirements
- B. Fabrication: Welded 18 gage stainless steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. ABS thermoplastic korad acrylic or stainless steel cover. Provide graduated boots for top

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

entrance and 2x8 wood nailer for side entrance. Coordinate with roofing contractor to install curb and roof cricket.

- C. Provide curbs for piping penetrations of roofing where the roof has a slope of 1" in 12" or less. Provide boots for piping penetrations where slope is greater than 1" in 12"

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick stainless steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick stainless steel.
- C. Sealant: Acrylic (where not through rated entity); refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Ferrous elements shall be stainless steel.

2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: 12 gage thick stainless steel. With holes 1-1/2 inches on center.

2.8 EXTERIOR PIPE SUPPORTS

- A. Manufacturers:
 - 1. MIRO
 - 2. ERICO CADDY
 - 3. Eberl Iron Works
 - 4. Substitutions: Section 01600 - Product Requirements

- B. Pipes 1-1/2" and smaller
1. MIRO model: 1.5
 2. Pipe support is 6" square and the base is gently rounded to prevent gouging the roof. The outer edges are raised 1-1/2" and increased elevations may be achieved by stacking Model 1.5 on 2 or 3 spacers, each with a height of 1-1/2". Four drainage ports are provided to prevent ponding within the device. The dimensional area resting on the roof is 5-7/8 inches square and 34.52 square inches exist of contact roof support.
 3. Pipe support shall be constructed of a one-piece roof deck base made of MIRON TPCTM or polycarbonate resin with, stacking/alignment pins, and interior cross hatch support structure. Carbon black added for UV resistance and protection.
 4. Pipe support shall be compatible for use with all current types of decking and with all commonly used built-up and single-ply roofing membranes where roof-mounted pipes occur.
- C. Pipes 1-1/2" - 3"
1. MIRO model: 3-R-2
 2. A "roller-bearing" pipe support used to support roof mounted gas pipes, electrical conduit, solar piping and other mechanical piping. Unique design absorbs thermal expansion and contraction of pipes thus preventing damage to the roof membrane. Pipes rest on a polycarbonate resin roller and a polycarbonate axle situated in a MIRON TPCTM or polycarbonate resin base.
 3. The polycarbonate roller serves to keep the pipestand system directly beneath the pipe without binding. It also allows for some lateral expansion of the pipe system. Guide holes are provided at the top of the cradle for any desired installation of a MIRO Pipe Strap using #8 x 1/2" screws to prevent separation of the pipe from the support. The base is gently rounded to prevent gouging the roof membrane.
 4. Support shall be a one-piece roof deck base, a roller housing support composed of rigid polycarbonate resin with carbon black added for UV resistance and protection, and a roller made of polycarbonate resin which rests on a MIRON TPCTM or polycarbonate axle of 9/16" diameter.
 5. Pipe support shall be compatible for use with all current types of decking and with all commonly used built-up and single-ply roofing membranes where roof-mounted pipes occur.
- D. Pipes 3-1/2" - 6"
1. MIRO model: 6-RAH
 2. A "roller-bearing" pipe support used to support roof mounted gas pipes, electrical conduit, solar piping and other mechanical piping. Unique design absorbs thermal expansion and contraction of pipes thus preventing damage to the roof membrane. Pipes rest on a self-lubricating roller which is a 304 stainless steel rod and a polycarbonate resin roller. The pipe support base is made of sturdy MIRON TPCTM or polycarbonate resin, the roller is polycarbonate and all metal parts are made of stainless steel.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3. The "U" shaped roller serves to keep the pipestand roller system directly beneath the pipe without binding and allows for some lateral expansion of the piping system.
4. The pipestand consists of two major components: (1) A one-piece polycarbonate resin roof deck base, (2) A roller made of polycarbonate resin and a stainless steel rod which rests in an adjustable height roller housing connected with 1/2" diameter stainless steel all thread on the base. Carbon black is added to the MIRON TPCTM and polycarbonate resin for UV resistance and protection.

2.9 ROOF MOUNTED DUCT SUPPORTS

A. Manufacturers:

1. ERICO CADDY – H-Frame Series
2. MIRO Industries
3. Eberl Iron Works
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Construction:

1. Unit shall be manufactured from UV stabilized polypropylene and polyethylene.
2. Bottom of base shall provided with a foam pad that offers low abrasion interface.
3. Unit shall be constructed in a manor to evenly distribute the weight across the entire footprint go the HVAC unit.
4. Provide all channel and hardware required for complete installation. All channel and hardware shall be hot-dip galvanized.

2.10 ROOF MOUNTED HVAC EQUIPMENT SUPPORTS

A. Manufacturers:

1. ERICO Caddy – Pyramid Equipment Support
2. MIRO Industries
3. Eberl Iron Works
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Construction:

1. Unit shall be manufactured from UV stabilized polypropylene and polyethylene.
2. Bottom of base shall provided with a foam pad that offers low abrasion interface.
3. Unit shall be constructed in a manor to evenly distribute the weight across the entire footprint go the HVAC unit.
4. Cross-bars, frame, clamps and all hardware shall be hot-dip galvanized.
5. Unit shall have a minimum height adjustment from 12" to 18".

2.11 ROOF MOUNTED PIPE SUPPORTS (FOR SINGLE PIPES)

A. Manufacturers:

1. MIRO Industries
2. ERICO Caddy
3. Eberl Iron Works

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

4. Substitutions: Section 01 60 00 - Product Requirements.
- B. 3" and Smaller
1. Base – 7-3/4"x7-3/4" with rounded edges, one piece polycarbonate resin with carbon black added for UV resistance.
 2. Roller – "U" Shaped cradle, polycarbonate resin with carbon black added for UV resistance. Axle is 9/16" diameter polycarbonate resin.
 3. Each pipe stand will accommodate up to 3-3/4" outside diameter pipe. Top of cradle shall be minimum 4" above the roof membrane.
 4. MIRO model 3-R-4.
- C. 3-1/2" thru 6"
1. Base – 16"x 18" with rounded edges, one piece polycarbonate resin with carbon black added for UV resistance.
 2. Roller – "U" Shaped self-lubricating cradle, polycarbonate resin with carbon black added for UV resistance. Axle is 304 stainless steel.
 3. Each pipe stand will accommodate up to 8-1/2" outside diameter pipe. Top of cradle shall be minimum 4" above the roof membrane.
 4. MIRO model 6-RAH-7.

2.12 ROOF MOUNTED PIPE SUPPORTS (FOR MULTIPLE PIPES)

- A. Manufacturers:
1. MIRO Industries
 2. ERICO Caddy
 3. Eberl Iron Works
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Base - 20"x 18" with rounded edges, one piece polycarbonate resin with carbon black added for UV resistance.
- C. Strut – Hot dipped galvanized mounted on base. Top of strut support shall be minimum 4" above the roof membrane.
- D. MIRO model 20-Base Strut.

2.13 FIRESTOPPING

- A. Manufacturers:
1. 3M Fire Protection Products.
 2. Nelson Firestop Products.
 3. Johns Manville
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Materials:
1. Caulk: CP25 (must be brick red)
 2. Wrap/Strip: FS-195

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3. Collar: RC-1
4. Composite Sheet: CS-195
5. Fire Barrier Moldable putty
6. Fire Dam Spray

2.14 FIRESAFING

- A. Manufacturer
 1. USG Acoustical Products
- B. Materials
 1. 4 inch mineral fiber stuffing insulation
 2. Density: 4 lb/cu ft.

2.15 ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- C. Labels: Red permanent marking "Fire Rated Assembly-Do not Disturb-See maintenance Instructions", include testing agency designation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install non-combustible backing damming materials to arrest liquid material leakage.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- D. Remove backing damming materials after firestopping material has solidified in exposed areas.
- E. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab/plank from below and provide through-bolt with recessed square steel plate and nut above flush with top of, recessed into and grouted flush with slab/plank as indicated on plans or directed by plank manufacturer. Where slab is utilized and direction is not given on plans then confirm with architect for method of attachment.

3.4 FIRESTOPPING/FIRESAFING

- A. Install as indicated by UL to maintain rating indicated by architectural plans.

3.5 INSTALLATION – DUST MITIGATION

- A. Seal pipes at any wall airtight. Apply sealant to both sides of penetration to completely fill annular space between sleeve and pipe and between sleeve and wall.

3.6 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with manufacturer's recommendation and this specification.
- B. Support horizontal piping as scheduled.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support vertical piping at every floor.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- F. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- G. Support riser piping independently of connected horizontal piping.
- H. Design hangers for pipe movement without disengagement of supported pipe.
- I. Piping shall be attached such that there is a 3" air space between any pipe and wall, ceiling or structural member such that cleaning pipe may be facilitated. Insulated pipe shall maintain a 3" air space between the insulation and any wall, ceiling or structural member. Refer to Section 22 07 00.

3.7 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 4 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.8 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- C. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- D. Flash and counter-flash roof curbs with sheet metal; seal watertight. Attach counterflashing and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars and pipe boots tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.9 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves two pipe sizes larger than penetrating pipe to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates a fire rated or smoke rated floor, ceiling, or wall, close off space between pipe or duct and adjacent work with approved firestopping system. Provide close fitting metal collar or escutcheon covers at both sides of penetration where penetration is exposed.
- F. Install stainless steel escutcheons at finished surfaces.

3.10 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.11 CLEANING

- A. Section 01 70 00 - Execution Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.12 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing, adjusting, and balancing of air systems.
 - 2. Testing, adjusting, and balancing of existing air systems that are modified during project.
 - 3. Testing, adjusting, and balancing of hydronic, refrigerating systems and pool systems.
 - 4. Testing, adjusting, and balancing of existing hydronic systems that are modified during project.
 - 5. Measurement of final operating condition of HVAC systems.
- B. Related Sections:
 - 1. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or forms prepared following ASHRAE 111 or NEBB Report. Results of "light tests" shall be written up as a letter to the Architect/Engineer on company

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

letterhead with the signatures of the code official who witnessed tests as well as the individual who conducted test.

- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with state standards.
- B. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance or ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience by certified by AABC or Certified by NEBB.
- B. Agency shall be 100% independent of any affiliations with general or installing contractors, manufactures, or design engineers.
- C. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Schedule and provide assistance in final adjustment and test of life safety systems with Fire Authority.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Re-balance existing hydronic systems and outside air systems. Field verify existing systems prior to starting work.
- C. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper T&B of systems and equipment.
- D. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Note the locations of devices that are not accessible for testing and balancing.
- E. Examine the approved submittals for HVAC systems and equipment.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- F. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- G. Examine equipment performance data including fan and pump curves.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor, and functioning.
- J. Examine strainers to verify that mechanical contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.
- K. Examine two-way valves for proper installation and function.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Prepare a T&B plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- C. Prepare system-readiness checklists for use by systems installers in verifying system readiness for T&B. These shall include, at a minimum, the following:
 - 1. Airside:
 - a. Ductwork is complete with terminals installed.
 - b. Air terminals are installed.
 - c. Volume, smoke and fire dampers are open and functional.
 - d. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - e. Fans are operating, free of vibration, and rotating in correct direction.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- f. Variable-frequency controllers' start-up is complete and safeties are verified.
 - g. Fire, smoke and volume dampers are in place, open and functional.
 - h. Air coil fins are cleaned and combed.
 - i. Access doors are closed and duct end caps are in place.
 - j. Automatic temperature control systems are operational.
 - k. Ceilings are installed.
 - l. Windows and doors are installed.
 - m. Suitable access to balancing devices and equipment is provided.
 - n. Proper thermal overload protection is in place for electrical equipment.
 - o. Duct system leakage is minimized.
2. Hydronics:
- a. Piping is complete with terminals installed.
 - b. Water treatment is complete.
 - c. Systems are flushed, filled and air purged.
 - d. Strainers are pulled and cleaned.
 - e. Control valves are functioning per the sequence of operation.
 - f. Shutoff and balance valves have been verified to be 100 percent open.
 - g. Pumps are started and proper rotation is verified.
 - h. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - i. Variable -frequency controllers' start-up is complete and safeties are verified.
 - j. Suitable access to balancing devices and equipment is provided.
- D. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems (Supply, return and exhaust): Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Minimum outside air: Adjust to within zero to plus 10 percent of design.
- D. Maintaining pressure relationships as designed shall have priority over the tolerances above.
- E. Hydronic Systems (Heating and cooling): Adjust to within plus or minus 10 percent of design.
- F. Flows through finned tube boiler must be between manufacturers' minimum and maximum values and 10% of design.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- G. Water temperatures are to be at or within 2 degrees Fahrenheit under indicated temperatures.
- H. Duct leakage: Air leakage shall not exceed limits below when tested in accordance with Chapter 5 of the AABC National Standard Manual. Duct shall not be pressure tested greater than their pressure class. Where testing indicated below exceeds the pressure class of ductwork, the leakage test shall be conducted at the pressure for which the duct is rated.
 - 1. Duct serving HVAC equipment with fans of less than one half horsepower: 2 percent at 0.5" WC.
 - 2. Duct serving HVAC equipment with fans of one half horsepower or greater but less than one horsepower: 2 percent at 1.0" WC.
 - 3. Duct serving HVAC equipment with fans of 1 horsepower or greater: 1 percent at 1.0" WC.
 - 4. Duct serving inlet side of VAV Box: 1 percent at 4"WC.
 - 5. HVAC duct within fire rated chases or ceilings: 1 percent at 3"WC.
 - 6. HVAC duct concealed by drywall or masonry walls or ceilings: 1 percent at 3"WC.
 - 7. HVAC duct routed through an attic space or other unconditioned space: 1 percent at 3"WC.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner or Engineer.

3.5 AIR SYSTEM PROCEDURE

- A. Perform an air leakage test on all architectural chases used to convey air prior to the installation of wall finishes.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- C. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- D. Measure air quantities at air inlets and outlets.
- E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- F. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- G. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- M. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure in Hotel lobby.
- N. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- O. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- P. On fan powered VAV boxes, adjust airflow switches for proper operation.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- Q. Exhaust ductwork serving Type I hoods shall be tested for leakage using a “light test” as described by the latest edition of International Mechanical Codes. The mechanical code official having jurisdiction shall witness light test. Ductwork tested using “light test” is not required to be leakage tested in accordance with Chapter 5 of the AABC National Standard Manual.

3.6 WATER SYSTEM PROCEDURE

- A. Prepare test reports for pumps, coils and heat exchangers. Obtain approved submittals and any manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Verify that hydronic systems are ready for testing and balancing:
1. Check liquid level in expansion tank.
 2. Check that makeup water-has adequate pressure to highest vent.
 3. Check that control valves are in their proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.
- C. Adjust water systems, after air balancing, to obtain design quantities.
- D. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- E. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- F. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- G. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- H. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
1. Plumbing Pumps.
 2. HVAC Pumps.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3. Packaged Roof Top Heating/Cooling Units.
4. Air Coils.
5. Fan Coil Units.
6. Air Handling Units.
7. Fans.
8. Air Inlets and Outlets.
9. Heat Exchangers.
10. Domestic hot water system

B. Report Forms

1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Report date
2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Sheave Make/Size/Bore
5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- c. Driven sheave, diameter and RPM
- d. Belt, size and quantity
- e. Motor sheave diameter and RPM
- f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
7. Combustion Test:
 - a. Manufacturer
 - b. Model number
 - c. Gas pressure at meter outlet
 - d. Gas flow rate
 - e. Burner manifold gas pressure
 - f. Percent carbon monoxide (CO)
 - g. Percent carbon dioxide (CO₂)
 - h. Percent oxygen (O₂)
 - i. Percent excess air
 - j. Flue gas temperature at outlet
 - k. Ambient temperature
8. Air Cooled Condenser:
 - a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Entering DB air temperature, design and actual
 - f. Leaving DB air temperature, design and actual
9. Heat Exchanger:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Primary water entering temperature, design and actual
 - h. Primary water leaving temperature, design and actual
 - i. Primary water flow, design and actual
 - j. Primary water pressure drop, design and actual
 - k. Secondary water leaving temperature, design and actual
 - l. Secondary water leaving temperature, design and actual

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- m. Secondary water flow, design and actual
- n. Secondary water pressure drop, design and actual
- 10. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual
- 11. Air Moving Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Arrangement
 - e. Air flow, specified and actual
 - f. Return air flow, specified and actual
 - g. Outside air flow, specified and actual
 - h. Total static pressure (total external), specified and actual
 - i. Inlet pressure
 - j. Discharge pressure
 - k. Sheave Make/Size/Bore
 - l. Number of Belts/Make/Size
 - m. Fan RPM
- 12. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
- 13. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Air flow, specified and actual
 - e. Total static pressure (total external), specified and actual
 - f. Number of Belts/Make/Size
 - g. Fan RPM
- 14. Duct Traverse:
 - a. System zone/branch

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
15. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
16. Flow Measuring Station:
- a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Design Flow rate
 - g. Design pressure drop
 - h. Actual/final pressure drop
 - i. Actual/final flow rate
17. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Design air flow
 - f. Test (final) air flow
 - g. Percent of design air flow

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes control equipment and software.
- B. Related Sections:
 - 1. Section 23 09 00 - Instrumentation and Control for HVAC: Control system components.
 - 2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
 - 3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Submit 10 complete sets of documentation in the following phased delivery schedule:
 - 1. Valve and damper schedules
 - 2. Equipment data cut sheets
 - 3. System schematics, including:
 - a. sequence of operations
 - b. point addresses
 - c. interface wiring diagrams
 - d. panel layouts
 - e. system riser diagrams
 - 4. Auto-CAD compatible as-built drawings.
- C. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 - 1. Index sheet, listing contents in alphabetical order
 - 2. Manufacturer's equipment parts list of all functional components of the system
 - 3. Auto-CAD disk of system schematics, including wiring diagrams
 - 4. Description of sequence of operations
 - 5. As-Built interconnection wiring diagrams
 - 6. Operator's Manual

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

7. Trunk cable schematic showing remote electronic panel locations, and all trunk data
8. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
9. Conduit routing diagrams.

1.4 DESCRIPTION

- A. Existing system to be expanded upon and reprogrammed to accept and control new equipment. Field verify existing system manufacturer and components and programming requirements prior to starting work.

1.5 QUALITY ASSURANCE

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
 1. The manufacturer shall provide full time, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S.
 2. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project. A maintained service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX, and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ, and QVAX, and be so listed at the time of Bid.
- D. The BAS peer-to-peer network controllers and local user display shall also comply with the Australian Electromagnetic Compatibility (EMC) Framework, and bear the C-Tic Mark to show compliance. The purpose of the regulation is to minimize electromagnetic

interference between electronic products, which may diminish the performance of electrical products or disrupt essential communications.

- E. DDC peer-to-peer controllers shall be compliant with the European EMC Directive, Standards EN 50081-2 and EN 50082-2, at the Industrial Levels. Additionally the equipment shall be compliant with the European LVD Directive and bear the CE mark in order to show compliance to both Directives.
- F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- G. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- H. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.
 - 1. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.6 WARRANTY

- A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after beneficial use.
- B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.
- C. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.
 - 1. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Existing.
- B. No Substitutions

2.2 HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
- B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:
 - 1. Control processes
 - 2. Energy management applications
 - 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - 4. Historical/trend data for points specified
 - 5. Maintenance support applications
 - 6. Custom processes
 - 7. Operator I/O
 - 8. Remote communications
- C. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
- D. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- E. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- F. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - 1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.3 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

- A. General:
 1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
 2. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
 3. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).
- B. Control Software Description:
 1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
 - a. Two-position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops.
- C. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
 2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 4. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
- D. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform

distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after-hours destinations) or based on priority.
 4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
 5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
- E. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of __ data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
 2. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
 - a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- F. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- G. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstation without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
- H. The peer-to-peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each operator individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

PART 3 EXECUTION

3.1 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule
 - 2. On-site coordination with all applicable trades, subcontractors, and other integration vendors
 - 3. Authorized to accept and execute orders or instructions from owner/architect
 - 4. Attend project meetings as necessary to avoid conflicts and delays
 - 5. Make necessary field decisions relating to this scope of work
 - 6. Coordination/Single point of contact

3.2 Minimum Point Monitoring (A = Analog, D = Digital, O = Output, I = Input)

- A. Rooftop Air Handlers
 - 1. Supply Fan S/S
 - 2. Supply Fan Proof
 - 3. Exhaust Fan S/S
 - 4. Exhaust Fan Proof
 - 5. Gas Heat

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

6. Cooling Valve
7. Stage 1 Dehumidification
8. Stage 2 Dehumidification
9. Stage 1 Dehumidification Allowed
10. OA Damper Position
11. Room Air Relative Humidity
12. Supply Air Temp
13. Outside Air Temp
14. Outside Air Relative Humidity
15. Filter Switch
16. Occupied Status
17. Outside Air Face and Bypass Position
18. Mixed Air Temperature
19. Mixed Air Relative Humidity
20. Discharge Air Temperature

3.3 INSTALLATION

- A. Install flow measurement devices in accordance with manufacturer's instructions at the locations indicated on the plans.
 1. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.
- B. Install labels and nameplates to identify control components according to Section 230553 or 260553.
- C. Install electronic cables according to Section 26
- D. Install low-voltage power, signal and communication cable according to Section 260519.

3.4 ADJUSTING

- A. Fan inlet mounted devices may be adjusted during start up and only after having been checked against known volumetric values (or against another like device measuring the same air volume) at two or more points of operation.

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes Sequence of Operation for:
 - 1. Air Handlers
 - 2. Packaged rooftop equipment
 - 3. Fan Coils
 - 4. Exhaust Fans
 - 5. Dehumidification Units
 - 6. Boilers
 - 7. Gas Fired Rooftop Make-Up Air Units
 - 8. Fan Coils
 - 9. Exhaust Fans
 - 10. High Volume Low Velocity Fans
 - 11. Air Curtains
 - 12. Infrared Heaters
 - 13. Ceiling Fans

- B. Related Sections:
 - 1. Section 23 34 00 HVAC Fans: For equipment, devices, and system components to implement sequences of operation
 - 2. Section 23 74 13 Packaged, Outdoor, Central Station Air Handling Units: For equipment, devices, and system components to implement sequences of operation

1.2 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures

- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 - 4. Coordinate submittals with information requested in Section 230900.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 ROOF MOUNTED AIR HANDLING UNITS (AHU-101)

- A. Run Conditions - Scheduled: The unit shall run according to a user-definable time schedule in the following modes:
 - 1. Occupied Mode: The unit shall maintain a cooling setpoint of 74°F (adj.) and a heating setpoint of 70°F (adj.).
- B. Outside Air Damper:
 - 1. The damper shall open anytime the unit runs and shall close anytime the unit stops.
 - a. When open the damper shall open to minimum outside air setpoint unless otherwise commanded.
 - b. When open the damper shall modulate open more than minimum in response to requirements of economizer.
 - 2. The damper shall have the following delay:
 - a. A 1 min (adj.) delay after the supply fan stops.
 - 3. Alarms shall be provided as follows:
 - a. OA Damper Failure: Commanded open, but the status is closed.
 - b. OA Damper in hand: Commanded closed, but the status is open.
- C. Supply Fan:
 - 1. The supply fan shall run anytime the unit is in occupied mode. The fan shall run for a minimum of 5 min (adj.) and be off a minimum of 5 min (adj.) unless shutdown on safeties.
 - 2. The fan shall have the following delay:
 - a. A 2 min (adj.) delay on start only after the outside air damper has been proven open through its end switch.
 - 3. Alarms shall be provided as follows:
 - a. Supply Fan Failure: Commanded on, but the status is off.
 - b. Supply Fan in hand: Commanded off, but the status is on

D. Exhaust Fan:

1. The Exhaust fan shall run anytime the unit is in occupied mode. The fan shall run for a minimum of 5 min (adj.) and be off a minimum of 5 min (adj.) unless shutdown on safeties.
 2. The exhaust fan shall modulate to maintain a differential pressure of negative 0.5 in WC (adj.) as compared to the adjacent corridor.
 3. The fan shall have the following delay:
 - a. A 2 min (adj.) delay on start only after the outside air damper has been proven open through its end switch.
 4. Alarms shall be provided as follows:
 - a. Supply Fan Failure: Commanded on, but the status is off.
 - b. Supply Fan in hand: Commanded off, but the status is on
- E. Cooling Coil:
1. The controller shall measure the OA air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
 2. The cooling stages shall be enabled whenever:
 - a. Outside air temperature is greater than 65°F (adj.).
 - b. AND the fan status is on.
 - c. AND the heating is not active.
- F. Dehumidification:
1. When unit is operating and neither cooling nor heating is required the controller shall measure the return air humidity and override the cooling sequence to maintain a return air humidity setpoint of 60% rh (adj.). The dehumidification shall turn off whenever the return air humidity drops below 55% rh (adj.).
 2. Dehumidification shall utilize only the first stage cooling coil.
 3. The controller shall utilize the gas heating furnace for reheat when cooling is not required but dehumidification is. The reheating coil shall modulate to maintain discharge air setpoint:
 4. Dehumidification shall be enabled whenever fan status is on.
- G. Heating Stages:
1. The controller shall measure the zone/OA air temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, there shall be a 5 min (adj.) delay between stages and each stage shall run a minimum of 1 min (adj.).
 2. The heating stages shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).
 - b. AND the fan status is on.
- H. Economizer: The controller shall measure the zone temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint.
1. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off.
 2. The economizer shall be enabled whenever:
 - a. Outside air temperature is less than 65°F (adj.).

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- b. AND the outside air enthalpy is less than 22Btu/lb (adj.)
 - c. AND the outside air temperature is less than the return air temperature.
 - d. AND the outside air enthalpy is less than the return air enthalpy.
 - e. AND the fan status is on.
3. The economizer shall not be in operation (adj.) whenever:
- a. Mixed air temperature is less than 35°F (adj.).
 - b. OR on loss of fan status
 - c. OR the freezestat is on.
4. Alarms shall be provided as follows:
- a. High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 - b. Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- I. Emergency unit shut down:
- 1. Unit shall shut down upon activation of grease hood fire suppression system. Coordinate with fire alarm contractor.
 - 2. Unit shall shut down upon detection of smoke in smoke in return or supply duct (two detectors). Coordinate with fire alarm contractor.
- J. Remote Space Temperature Sensor:
- 1. Remote sensor(s) (refer to drawings for quantities and locations) shall report to AHU thermostat. The AHU controller shall stage heating and cooling based on remote space temperature setting.
 - 2. Additional controls required to meet performance objectives shall be provided.
- 3.2 EXHAUST FANS
- A. Unit shall be commanded “on” by wall switch interlocked with bathroom light. Fan shall remain “on” for 5 minutes after light is turned “off”

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 23 74 13

PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes modular factory fabricated air-handling units and accessories.
- B. Related Sections:
 - 1. Section 23 07 00 - HVAC Insulation: Product requirements for insulation for placement by this section.
 - 2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 3. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and hot water piping connections to air handling units.
 - 4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
 - 5. Section 23 33 00 - Air Duct Accessories: Product requirements for flexible duct connections for placement by this section.
 - 6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - 5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
 - 2. ARI 430 - Central-Station Air-Handling Units.
 - 3. ARI 610 - Central System Humidifiers for Residential Applications.
 - 4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.
- D. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- F. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- G. Underwriters Laboratories Inc.:
 - 1. UL 900 - Air Filter Units.
 - 2. UL - Fire Resistance Directory.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- C. Product Data, Submit the following:
 - 1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
 - 6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.
- D. Samples: Submit two of each type of replacement filter media with frame.
- E. Manufacturer's Installation Instructions: Submit.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Outside Air Damper Leakage: Test in accordance with AMCA 500.
- B. Maintain one copy of each document on site.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for air handling units.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of fan belts for each unit.
- C. Furnish one set of filters for each unit.

PART 2 PRODUCTS

2.1 AIR HANDLING UNITS

- A. Manufacturers:
 - 1. York
 - 2. Substitutions: Not allowed
- B. Configuration: Refer to drawings.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

C. Fabrication: Conform to AMCA 99 and ARI 430.

2.2 CASING

A. Channel base and drain pan of welded steel. Assemble sections with gaskets and bolts.

B. Outside Casing:

1. Galvanized Steel: 0.0635 inch (1.6 mm).
2. Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket.
3. Furnish cap strips over roof flanges. Furnish rain caps and gaskets on access doors.

C. Outside Casing Finish:

1. Baked enamel
2. Finish exceeds 500 hour salt spray test in accordance with ASTM B117.
3. Color: As selected by Architect/Engineer.

D. Inside Casing:

1. Stainless Steel: Solid, 0.025 inch (0.65 mm) thick.

E. Floor Plate:

1. Stainless Steel: 0.1406 inch (3.6 mm) thick.

F. Insulation: Neoprene coated, glass fiber, applied to internal surfaces with adhesive and weld pins with exposed edges of insulation coated with adhesive.

1. 'K' ('Ksi') factor at 75 degrees F (42 degrees C): Maximum 0.26 Btuh inch/ sq ft/ degrees F (0.037 W/m/Degree K).
2. Density: 2 inch (50 mm) thick, 1-1/2lbs/cu ft (96 kg/cu m).

G. Walk-in Access Doors: Insulated sandwich construction same as cabinet, for flush mounting, with hinges, gasket, latch, and handle assemblies, and 12 x 12 inch (300 x 300 mm) inspection window of 1/4 inch (6 mm) thick Plexiglas.

H. Lights: Located in accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch and pilot light and duplex outlet mounted on casing exterior. In humidifier sections, furnish lights suitable for wet locations.

I. Drain Pans: Double thickness stainless steel with insulation between layers with welded corners. Cross break and pitch to drain connection. Furnish drain pans under cooling coil section.

J. Bottom Inlet Units: Furnish aluminum walking grate on structural supports.

K. Strength: Furnish structure to brace casings for suction pressure of 2.5 inch wg (600 Pa), with maximum deflection of 1 in 200.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.3 FANS

- A. Type: plug type fan.
- B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with plastic aluminum copper tube and grease fitting rigidly attached to casing.
- E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Furnish built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast. Mount base on vibration isolators.
- F. Fan Modulation: Variable Frequency Drive. To be factory mounted and wired.
- G. Flexible Connection: Separate unit from connecting ductwork.

2.4 MOTORS

- A. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.15.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.5 BEARINGS AND DRIVES

- A. Bearings: Pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9 L-50 life at 100,000 hours.
- B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
- C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
- D. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.6 COILS

- A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch (600 mm) downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- D. Fabrication:
 - 1. Tubes: 5/8 inch (16 mm) OD seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum.
 - 3. Casing: Die formed channel frame of stainless steel.
 - 4. Heresite coating
- E. Water Cooling Coils:
 - 1. Headers: copper tube
 - 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.7 Gas Heating:

- A. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
- C. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
- D. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
- E. Natural gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heating assemblies shall be capable of operating at any firing rate between 100% and 20% of their rated capacity.

2.8 FILTERS

- A. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.
- B. Filter Media: UL 900 listed, Class I.
- C. Flat: 2 inches (50 mm) deep disposable panel filters.
- D. Filter Gauges: 3-1/2 inch (90 mm) diameter diaphragm actuated dial in metal case, with static pressure tips.

2.9 ECONOMIZER

- A. Provide economizer components and controls in accordance with ICC IECC.

2.10 DAMPERS

- A. Mixing Boxes: Section with factory mounted outside and return air dampers of stainless steel with vinyl bulb edging and edge seals in stainless frame, with stainless steel axles in self-lubricating nylon bearings, in parallel blade arrangement. Furnish removable, full width support for freeze-protection thermostat, with removable end panel to permit support removal.
- B. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot (0.13 L/s per square meter) at 1.0 inches wg (250 Pa) pressure differential.
- C. Face and Bypass Dampers: Factory mount in casing with access doors, of stainless steel blades, with vinyl bulb edging and edge seals, stainless steel frame, and axles in self-lubricating nylon

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

bearings. Arrange to match coil face with top bypass, blank-off and division sheets, internal linkage, access doors, and adjustable resistance plate.

- D. Damper Actuators: Furnish factory installed electric electronic damper actuators for outside air, return air, and exhaust air dampers face and bypass dampers.

2.11 ACCESSORIES

- A. UV biofilm lighting system to be equivalent to Fresh-Aire UV model: TUVC-TRS. Power is to be derived from Cabinet power and installed in each cabinet as described on the drawings.

2.12 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Disconnect Switch: Factory mount on equipment.
- B. Provide single point wiring for equipment to include all conduit, conductors, and transformers required so that all components and controls associated with equipment are powered by one power feed to the equipment.
- C. Motor Drive: Variable speed drive for supply fan factory mounted and wired.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.2 INSTALLATION

- A. Install in accordance with ARI 430.
- B. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum **1 inch (25 mm)** flex between ductwork and fan while running. Refer to Section 23 33 00.
- C. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating. Refer to Section 23 05 48.
- D. Install condensate piping with trap and route from drain pan to nearest roof drain or gutter.
- E. Provide fixed sheaves required for final air balance.
- F. Insulate coil headers located outside airflow as specified for piping. Refer to Section 23 07 00.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.3 INSTALLATION CHILLED WATER COOLING COIL

- A. Make connections to coils with unions or flanges.
- B. Connect water supply to leaving airside of coil (counter flow arrangement).
- C. Locate water supply at bottom of supply header and return water connection at top.
- D. Install water coils to allow draining and install drain connection at low points.
- E. Install the following piping accessories on chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
 - 1. On supply:
 - a. Thermometer well and thermometer.
 - b. Well for control system temperature sensor.
 - c. Shutoff valve.
 - d. Strainer.
 - e. Control valve.
 - f. Pressure gage.
 - 2. On return:
 - a. Thermometer well and thermometer.
 - b. Well for control system temperature sensor.
 - c. Pressure gage.
 - d. Shutoff valve.
 - e. Balancing valve.
- F. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.7 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes building wire and cable; nonmetallic-sheathed cable; direct burial cable; service entrance cable; armored cable; metal clad cable; and wiring connectors and connections.
- B. Related Sections:
 - 1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. Underwriters Laboratories, Inc.:
 - 1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
 - 2. Stranded conductors for control circuits.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 4. Conductor not smaller than 14 AWG for control circuits.
 - 5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway unless otherwise noted on plans.
 - 2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3. Wet or Damp Interior Locations: Use only building wire, Type XHWN insulation, in raceway.
4. Exterior Locations: Use only building wire, Type XHHN/XHWN insulation, in raceway.
5. Underground Locations: Use only building wire, Type XHHW insulation, in raceway

1.4 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper unless indicated as aluminum or "AL".
- B. When aluminum conductor is substituted for copper conductor, size to match circuit requirements, terminations, conductor ampacity and voltage drop.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit for building wire and each cable assembly type.
- C. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.
- D. Test Reports: Indicate procedures and values obtained.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and circuits.

1.7 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.
- B. Maintain one copy copies of each document on site.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- C. Wire and cable routing indicated is approximate unless dimensioned. Include wire and cable lengths within 10 ft (3000 mm) of length shown.

PART 2 PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
 - 1. AETNA.
 - 2. American Insulated Wire Corp.
 - 3. Colonial Wire.
 - 4. Encore Wire.
 - 5. General Cable Co.
 - 6. Republic Wire.
 - 7. Rome Cable.
 - 8. Service Wire Co.
 - 9. Southwire.
 - 10. Superior Essex.
 - 11. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation Temperature Rating: 90 degrees C.
- F. Insulation Material: Thermoplastic.

2.2 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. Essex Group Inc.
 - 3. General Cable Co.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Conductor: Copper.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: Type XHHW-2.

2.3 TERMINATIONS

- A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify interior of building has been protected from weather.
- C. Verify mechanical work likely to damage wire and cable has been completed.
- D. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 EXISTING WORK

- A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.
- E. Clean and repair existing wire and cable remaining or wire and cable to be reinstalled.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.4 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 4 AWG and larger with pulling equipment.
- E. Special Techniques - Cable:
 - 1. Protect exposed cable from damage.
 - 2. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.
 - 3. Use suitable cable fittings and connectors.
- F. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 - 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- G. Install stranded conductors for branch circuits 10 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
- H. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.
- I. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- J. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.5 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.
- E. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, and UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
 - 1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.
- B. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with **0.10 inch water gage (24.9 Pa)** minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with **0.10 inch water gage (24.9 Pa)** minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy copies of each document on site.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum years documented experience approved by manufacturer.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Rocket Rack
 - 2. Substitutions: No Substitutions
- B. Hanger Rods: Threaded high tensile strength stainless steel with free running threads, and PVC coating
- C. Beam Clamps: Stainless Steel, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: Stainless steel.
- D. Conduit clamps for trapeze hangers: Stainless steel, notched to fit trapeze with single bolt to tighten.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

E. Conduit clamps – Stainless Steel

2.2 SLEEVES

- A. Sleeves for Through Non-fire Rated Floors: Stainless Steel conduit.
- B. Sleeves for Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Stainless Steel conduit.
- C. Sleeves for Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

2.3 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp.
 - 2. Fire Trak Corp.
 - 3. Hilti Corp.
 - 4. International Protective Coating Corp.
 - 5. 3M fire Protection Products
 - 6. Specified Technology, Inc.
 - 7. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 - 1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
 - 2. Foam Firestopping Compounds: Multiple component foam compound.
 - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
 - 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 - 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 - 7. Firestop Pillows: Formed mineral fiber pillows.
- C. Color: As selected from manufacturer's full range of colors.

2.4 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Dam Material: Permanent:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
 - 3. Sheet metal.
 - 4. Plywood or particle board.
 - 5. Alumina silicate fire board.

- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

- D. General:
 - 1. Furnish UL listed products or products tested by independent testing laboratory.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.

- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing and damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors and preset inserts.
 - 2. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
 - 3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
 - 4. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 - 5. Sheet Metal: Provide sheet metal screws.

- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

- C. Install conduit and raceway support and spacing in accordance with NEC.

- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

- E. Install multiple conduit runs on common hangers.

- F. Supports:
 - 1. Fabricate supports from stainless steel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. Support vertical conduit at every floor.

3.4 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

- D. Place intumescent coating in sufficient coats to achieve rating required.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Remove dam material after firestopping material has cured.
- F. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of **1 inch (25 mm)** on both sides of building element.
 - b. Size sleeve allowing minimum of **1 inch (25 mm)** void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, cable bus, conduit, wireway, trough, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- G. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of **1 inch (25 mm)** on both sides of building element.
 - b. Size sleeve allowing minimum of **1 inch (25 mm)** void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
 - 4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum **3-1/2 inches (87 mm)** thick and extending **6 inches (150 mm)** beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors **1 inch (25 mm)** above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections.
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Section 26 05 53 - Identification for Electrical Systems.
 - 5. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Underground More than 5 feet (1500 mm) outside Foundation Wall: Provide thickwall nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground Within 5 feet (1500 mm) from Foundation Wall: Provide thickwall nonmetallic conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall nonmetallic conduit. Provide cast or nonmetallic metal boxes.
- E. Outdoor Locations, Above Grade: Provide rigid aluminum conduit. Provide cast metal outlet, pull, and junction boxes.
- F. In Slab Above Grade: Provide thickwall nonmetallic conduit. Provide cast boxes.
- G. Wet and Damp Locations: Provide rigid aluminum conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. Concealed Dry Locations: Provide rigid aluminum conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Exposed Dry Locations: Provide rigid aluminum conduit. Provide aluminum (outdoor) boxes. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for the following:
 - 1. Flexible metal conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. Flexible nonmetallic conduit.
 - 5. Nonmetallic tubing.
 - 6. Raceway fittings.
 - 7. Conduit bodies.
 - 8. Surface raceway.
 - 9. Wireway.
 - 10. Pull and junction boxes.
 - 11. Handholes.
- C. Shop Drawings: Submit feeder conduit layout drawings, drawn to scale not smaller than 1/8 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1. Switchboard and Panel locations.
 2. Feeder conduit size and routing.
 3. Locations of pulling and access elements.
 4. Coordination between other utilities.
 5. Coordination with structural elements.
 6. Coordination with architectural elements, walls, and ceilings to show whether the conduit will be exposed or hidden by the architectural elements.
 7. Details showing the protection of penetrations through fire rated elements.
- D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents:
1. Record actual routing of conduits larger than 2 inch (DN50).
 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
1. Carlon Electrical Products.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. Hubbell Wiring Devices.
3. Thomas & Betts Corp.
4. Walker Systems Inc.
5. The Wiremold Co.
6. Substitutions: Section 01 60 00 - Product Requirements

- B. Rigid Aluminum Conduit: ANSI C80.5.
- C. Intermediate Metal Conduit (IMC): Rigid aluminum.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
1. Carlon Electrical Products
 2. Hubbell Wiring Devices.
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.
 5. The Wiremold Co.
 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Interlocked aluminum construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.3 NONMETALLIC CONDUIT

- A. Manufacturers:
1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.
 5. The Wiremold Co.
 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA TC 2; Schedule 80 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

2.4 OUTLET BOXES

- A. Manufacturers:
1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

5. The Wiremold Co.
 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.5 PULL AND JUNCTION BOXES

- A. Manufacturers:
1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.
 5. The Wiremold Co.
 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Cast aluminum.
 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- C. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
1. Material: Cast aluminum.
 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 3. Cover Legend: "ELECTRIC".
- D. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
1. Cable Entrance: Pre-cut **6 inch x 6 inch (150 mm x 150 mm)** cable entrance at center bottom of each side.
 2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

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

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maximum Size Conduit in Slab Above Grade: **3/4 inch (19 mm)**. Do not cross conduits in slab.
- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain **12 inch (300 mm)** clearance between raceway and surfaces with temperatures exceeding **104 degrees F (40 degrees C)**.
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than **2 inch (50 mm)** size.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- X. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
- B. Adjust box location up to **10 feet (3 m)** prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than **6 inches (150 mm)** from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum **6 inches (150 mm)** separation. Install with minimum **24 inches (600 mm)** separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- P. Surface mount device boxes in wall unless otherwise noted.
- Q. Caulk all surface mounted boxes to wall.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket or roof boot.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 27 05 33

CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 27 26 - Wiring Devices.
 - 4. Section 27 05 26 - Grounding and Bonding for Communications Systems.
 - 5. Section 27 05 29 - Hangers and Supports for Communications Systems.
 - 6. Section 27 05 36 - Cable Trays for Communications Systems.
 - 7. Section 27 05 53 - Identification for Communications Systems.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Underground More than 5 feet (1500 mm) outside Foundation Wall: Provide plastic coated conduit, thickwall nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground Within 5 feet (1500 mm) from Foundation Wall: Provide plastic coated conduit, thickwall nonmetallic conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall nonmetallic conduit. Provide cast or nonmetallic metal boxes.
- E. Outdoor Locations, Above Grade: Provide rigid aluminum conduit or thickwall non-metallic conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.
- F. In Slab Above Grade: Provide thickwall nonmetallic conduit. Provide cast boxes.
- G. Wet and Damp Locations: Provide rigid aluminum conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. Concealed Dry Locations: Provide rigid aluminum conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Concealed In Concrete Wall Locations: Provide thickwall nonmetallic conduit. Provide nonmetallic boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- J. Exposed Dry Locations: Provide rigid aluminum conduit. Provide aluminum NEMA 3R boxes. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for the following:
 - 1. Flexible metal conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. Flexible nonmetallic conduit.
 - 5. Nonmetallic tubing.
 - 6. Raceway fittings.
 - 7. Conduit bodies.
 - 8. Surface raceway.
 - 9. Wireway.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

10. Pull and junction boxes.
11. Handholes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 1. Record actual routing of conduits larger than 2 inch (DN50).
 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 1. Carlon Electrical Products.
 2. Hubbell Wiring Devices.
 3. Thomas & Betts Corp.
 4. Walker Systems Inc.
 5. The Wiremold Co.
 6. Substitutions: Section 01 60 00 - Product Requirements

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- B. Rigid Aluminum Conduit: ANSI C80.5.
- C. Intermediate Metal Conduit (IMC): Rigid aluminum.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel or malleable iron, compression type.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Interlocked aluminum construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.4 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA TC 2; Schedule 80 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2.5 OUTLET BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products
 - 2. Hubbell Wiring Devices
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch (13 mm) male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products
 - 2. Hubbell Wiring Devices
 - 3. Thomas & Betts Corp.
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Hinged Enclosures: As specified in Section 26 27 16.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Cast aluminum.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. In-Ground Cast Metal Box: NEMA 250, Type 6, inside flanged, recessed cover box for flush mounting:
 - 1. Material: Cast aluminum.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: "ELECTRIC".

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut **6 inch x 6 inch (150 mm x 150 mm)** cable entrance at center bottom of each side.
 - 2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maximum Size Conduit in Slab Above Grade: **3/4 inch (19 mm)**. Do not cross conduits in slab larger than **1/2 inch (DN 13)**.
- L. Maintain clearance between raceway and piping for maintenance purposes.
- M. Maintain **12 inch (300 mm)** clearance between raceway and surfaces with temperatures exceeding **104 degrees F (40 degrees C)**.
- N. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- O. Bring conduit to shoulder of fittings; fasten securely.
- P. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- Q. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- R. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch (50 mm) size.
- S. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- T. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- X. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings. specified in section for outlet device.
- B. Adjust box location up to 10 feet (3 m) prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches (150 mm) separation. Install with minimum 24 inches (600 mm) separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 00.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket or roof boot.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes fire alarm control panels, manual fire alarm stations, automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.
- B. Related Sections:
 - 1. Section 08 71 00 - Door Hardware: Door closers, electric locks, electric releases.
 - 2. Section 21 13 13 - Wet-Pipe Sprinkler Systems: Flow detection and alarm devices.
 - 3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 4. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 5. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 6. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 7. Section 28 05 53 - Identification for Electronic Safety and Security.

1.2 REFERENCES

- A. National Fire Protection Association:
 - 1. NFPA 72 - National Fire Alarm Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.3 SYSTEM DESCRIPTION

- A. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system with connections to municipal system.
- B. A general alarm will also activate all smoke detector sounder bases.
- C. Alarm Sequence of Operation: Actuation of initiating device causes the following system operations:
 - 1. Local fire alarm signaling devices sound and display with march time signal.
 - 2. Non-coded signal transmits to municipal connection.
 - 3. Location of alarm zone indicates on fire alarm control panel and on remote annunciator panel.
 - 4. Signal transmits by zone to building smoke removal system.
 - 5. Signal transmits to building elevator control panel, initiating return to main floor or alternate floor and lockout for fire service.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

6. Signal transmits to building mechanical controls, shutting down fans and operating dampers.
 7. Signal transmits by zone to release door hold-open devices.
 8. Signal releases magnetic door hold opens.
 9. Signal releases electric door locks.
- D. Drill Sequence of Operation: Manual drill function causes alarm mode sequence of operation.
- E. Trouble Sequence of Operation: System or circuit trouble causes the following system operations:
1. Visual and audible trouble alarm indicates by zone at fire alarm control panel.
 2. Visual and audible trouble alarm indicates at remote annunciator panel.
 3. Trouble signal transmits to remote station.
- F. General: Add onto an existing fire alarm system and install new annunciation devices and control components.
- G. Wiring/Signal Transmission:
1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
 2. System connections for initiating device circuits shall be Class A, Style A, signaling line circuits shall be Class A, Style 6, and notification appliance circuits shall be Class A, Style Z.
 3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- H. Required Functions: The following are required system functions and operating features:
1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
 2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.
 3. Transmission to an approved Supervising Station: Automatically route alarm, supervisory, and trouble signals to an approved supervising station service provider, under another contract.
 4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the type of

- device, the operational state of the device (i.e. alarm, trouble or supervisory) and shall display the custom label associated with the device.
5. General Alarm: A system general alarm shall include:
 - a. Indication of alarm condition at the FACP and the annunciator(s).
 - b. Identification of the device /zone that is the source of the alarm at the FACP and the annunciator(s).
 - c. Operation of audible and visible notification appliances until silenced at FACP.
 - d. Closing doors normally held open by magnetic door holders.
 - e. Unlocking designated doors.
 - f. Shutting down supply and return fans serving zone where alarm is initiated.
 - g. Closing smoke dampers on system serving zone where alarm is initiated.
 - h. Initiation of smoke control sequence.
 - i. Transmission of signal to the supervising station.
 - j. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated, as appropriate.
 6. Priority Two Operations: Upon activation of a priority two condition such as gas detection, the system shall operate as follows:
 - a. Activate the system priority two audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Priority 2 Acknowledge Key will silence the audible signal while maintaining the Priority 2 LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of priority two signal to the supervising station.
 - e. Restoring the condition shall cause the Priority 2 LED to clear and restore the system to normal.
 7. Supervisory Operations: Upon activation of a supervisory device such as a fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of supervisory signal to the supervising station.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
 8. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible and visible alarm signals shall cease operation.
 9. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the

- sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
- b. Should an alarm condition continue, the system will remain in an alarmed state.
 - c. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
10. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
- a. The city circuit connection and any suppression release circuits shall be bypassed for the testing group.
 - b. Control relay functions associated with one of the 8 testing groups shall be bypassed.
 - c. The control unit shall indicate a trouble condition.
 - d. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances assigned only to that group to sound a code to identify the device or zone.
 - e. The unit shall automatically reset itself after signaling is complete.
 - f. Any opening of an initiating device or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.
- I. Install Mode: The system shall provide the capability to group all non-commissioned points and devices into a single "Install Mode" trouble condition allowing an operator to more clearly identify event activations from commissioned points and devices and in occupied areas.
1. It shall be possible to individually remove points from Install Mode as required for phased system commissioning.
 2. It shall be possible to retrieve an Install Mode report listing that includes a list of all points assigned to the Install Mode. Panels not having an install mode shall be reprogrammed to remove any non-commissioned points and devices.
- J. Service Gateway: A Service Gateway software application shall be provided that allows an authorized service person to remotely query panel status during testing, commissioning, and service, without the need to return to the panel using standard email or instant messaging tools. For systems without a service gateway application the service provider shall provide a minimum of two technicians for any system testing or commissioning.
- K. Analog Smoke Sensors:

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to automatically indicate when a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system. If this indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Supervising Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
 6. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
 7. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
 8. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
 9. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.
- L. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:
1. Biannual sensitivity reading and logging for each smoke sensor.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
 3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
 4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
 5. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
 6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
 7. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.
- M. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.
1. Automatic Voice Evacuation Sequence:
 - a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the AAlarm Silence@ switch is activated.
 - b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.
- N. Speaker: Speaker notification appliances shall be listed to UL 1480.
1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
- O. Manual Voice Paging
1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.
 2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 3. Total building paging shall be accomplished by the means of an AAll Call@ switch.
- P. Fire Suppression Monitoring:
1. Water flow: Activation of a water flow switch shall initiate general alarm operations.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
 3. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
- Q. The system shall support NAC Lockout feature to prevent subsequent activation of releasing circuits after a Depleted Battery condition occurs.
- R. Power Requirements
1. The control unit shall receive AC power via a dedicated fused disconnect circuit.
 2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
 4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
 5. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
 6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
 7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
 8. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.
- S. Zoning: As indicated on Drawings.

1.4 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate annunciator layout, and design calculations.
- C. Product Data: Submit catalog data showing electrical characteristics and connection requirements.
- D. Test Reports: Indicate procedures and results for specified field testing and inspection.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- E. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01700 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of fire alarm equipment.
- C. Operation and Maintenance Data: Submit manufacturer=s standard operating and maintenance instructions.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of project.
- B. Installer: Certified fire alarm installer with service facilities within 100 miles of Project.
- C. Design fire alarm under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.7 MAINTENANCE SERVICE

- A. Section 01700 - Execution Requirements: Maintenance service.
- B. Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

1.8 MAINTENANCE MATERIALS

- A. Section 01700 - Execution Requirements: Spare parts and maintenance products.
- B. Furnish ten manual station break-glass rods.
- C. Furnish six keys of each type.

1.9 EXTRA MATERIALS

- A. Section 01700 - Execution Requirements: Spare parts and maintenance products.
- B. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. Notification Appliances: Furnish quantity equal to 10 percent of each type and number of units installed, but not less than one of each type.
3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of each type and number of units installed but not less than one of each type.
4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of each type and number of units installed but not less than one of each type.

PART 2 PRODUCTS

2.1 EXISTING SYSTEMS

- A. Field verify existing system type and capacities.
- B. Connect and expand existing systems using compatible devices and infrastructure.

2.2 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 5 minutes.

2.3 ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Protective Shield: Where required, as indicated on the drawings, provide a tamper proof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.4 SMOKE SENSORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 1. Factory Nameplate: Serial number and type identification.
 2. Operating Voltage: 24 VDC, nominal.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
 5. Quick Connect Arrangement: Photoelectric sensor and electronics in a single piece construction which shall twist-lock onto a mounting base that attaches to a standard electrical box.
 6. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
 7. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 8. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 9. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
 10. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
 11. Removal of the sensor head for cleaning shall not require the setting of addresses.
- B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type.
- C. Bases:
1. Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
 2. Guestroom detectors to include low frequency sounder base.
- D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
 2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@

120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.

3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated provide a NEMA 4X weatherproof duct housing enclosure that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

2.5 HEAT SENSORS

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.6 ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.

- C. There shall be the following types of modules:
1. Type 1: Monitor Circuit Interface Module:
 - a. For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
 - b. For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
 2. Type 2: Line Powered Monitor Circuit Interface Module
 - a. This type of module is an individually addressable module that has both its power and its communications supplied by the two wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
 - b. This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.
 3. Type 3: Single Address Multi-Point Interface Modules
 - a. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
 - b. This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
 - c. This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.
 4. Type 4: Line Powered Control Circuit Interface Module
 - a. This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.
 5. Type 5: 4-20 mA Analog Monitor Circuit Interface Module

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- a. This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.
- D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.7 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force. Coordinate power requirements with electrical trades.
- B. Material and Finish: Match door hardware.

2.8 ADDRESSABLE ALARM NOTIFICATION APPLIANCES

- A. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
 - 1. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
 - 2. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.
 - 3. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.
- B. Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

program the High/Low setting of the audible (horn) appliances by channel from the addressable controller.

- C. Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Low Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.
- D. Sounder Base: Addressable horn shall be listed to UL 268 and UL 464. Horn appliances shall have a High/Low Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. Provide Low Frequency option.
- E. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- F. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:
1. Synchronized Strobe with Horn on steady.
 2. Synchronized Strobe with Temporal Code Pattern on Horn.
 3. Synchronized Strobe with March Time cadence on Horn.
 4. Synchronized Strobe firing to NAC sync signal with Horn silenced.
- G. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 3. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for general signaling.
 4. The S/V installs directly to a 4" square, 2" deep electrical box with 2" extension.
- H. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:
1. Report faults to the host FACP.
 2. On-board Yellow LED provides module status.
 3. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.
- I. Accessories: The contractor shall furnish the necessary accessories.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
 1. Factory trained and certified personnel.
 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. Existing Fire Alarm Equipment shall be maintained fully operational until the new equipment has been tested and accepted.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- C. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.
- D. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.
- E. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.
- F. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.
- G. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- H. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, duct smoke detectors.
- I. Interconnect duct smoke detector with associated air moving equipment. Coordinate with mechanical trades.
- J. Automatic Detector Installation: Conform to NFPA 72.

3.3 PREPARATION

- A. Coordinate work of this Section with other affected work and construction schedule.

3.4 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

- D. Terminate circuit in control panel for Class "A" supervision.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
1. Factory trained and certified.
 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 3. International Municipal Signal Association (IMSA) fire alarm certified.
 4. Certified by a state or local authority.
 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning
- D. Inspection:
1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
 2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
- E. Acceptance Operational Tests:
1. Perform operational system tests to verify conformance with specifications:
 - a. Each alarm initiating device installed shall be operationally tested. Each device shall be tested for alarm and trouble conditions. Contractor shall submit a written certification that the Fire Alarm System installation is complete including all punch-list items. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified. Test Supervising Station Signal Transmitter. Coordinate testing with Supervising Station monitoring firm/entity.
 - b. Test each Notification Appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
 - c. Test Fire Alarm Control Panel and Remote Annunciator.
 2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction.

Martin's Famous Pastry Shoppe (1730)
Transportation Cafe
Chambersburg, Pennsylvania
September 20, 2018
Bid Set - Not For Construction Addendum #2 1-15-19

- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Use NFPA 72 Forms for documentation.
- H. Final Test, Record of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.6 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.7 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours training.
 - 2. Schedule training with the Owner at least seven days in advance.

END OF SECTION